Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

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THE NEW ASTRONOMY.

IV.—THE GALAXY AND AN IMMORTAL COSMOS.

By PROFESSOR A. W. BICKERTON.

THE more we study the stars, the more we are impressed with the fact that the stellar system is not a chance distribution, but on the contrary, that almost the entire content of the celestial vault that we can see, whether it be nebulae or stars, is a single organized system and has a definite boundary.

White, planetary and diffused nebulae; star clusters; temporary, variable and double stars, each and all occupy definite positions, every one of which offers striking evidence of a system of evolution as consistently simple as it is conclusively demonstrated.

Taken roughly as a whole, the Galactic Universe consists of a belt of stars, containing lateral streams, dense aggregations in parts, and equally striking defects of illumination in other parts. This rough ring or belt is possibly of a double spiral character: this opinion is very firmly held by Professor See and a number of other able astronomers. This belt of stars, which varies from some ten to twenty degrees in width, is almost exactly bisected by a great circle of the heavens. Leaving the margins of this stellar belt, we come upon two belts of the celestial sphere that are somewhat sparsely inhabited. Then, as we approach the two poles, we meet with an increasing number of nebulae. These seem to have their maximum density in both hemispheres in a position approximately that of the poles of the great circle of the Galaxy. (See Figure 1.) It is well to look upon this great circle as the equatorial plane of the Sidereal Universe. A vast number of these nebulae are, as described in our last article, of a double spiral character. They are, as a rule, what are called White Nebulae, that give continuous spectra, suggesting that they are dust swarms. There are comparatively few stars in the polar regions of the heavens. Stars are mostly confined to the equatorial belt, and it is in this same belt that we find nearly all the gaseous nebulae of the heavens. These vast masses of diffused gas are of two kinds, the one the planetary nebulae, already described. Usually, although very rare, these are extremely definite. The other class of gaseous nebulae, such as the great nebula in Orion (see Figure 4), is of extreme irregularity, usually quite devoid of any symmetry of form, yet exhibiting marked structure that often seems to suggest drifting motion. In this same Milky Way belt, in addition to gaseous nebulae, are to be found most of the beautiful star clusters. Nearly all the temporary stars have blazed out in this belt, and it is in this same belt that we find most of the variable, or wonder stars, most of the telescopic double stars, and spectroscopic binaries, and here also, although somewhat singularly situated, we find the Wolf-Rayet stars. But very few White Nebulae are found in the belt of the Milky Way. (See Figure 2.)

INDEPENDENT SIDEREAL SYSTEMS.

In addition to all that has been described, that seem to be parts of one consistent whole, we have other systems which it is not certain belong to our Galactic Universe at all. It is the opinion of Sir

David Gill that the great nebula of Andromeda (see Frontispiece) is a distant Sidereal system not unlike the Galactic system. This opinion of Sir David Gill is shared by other astronomers, who believe that in this beautiful oval patch of light we are looking upon an orderly system of millions of suns. From the brilliant centre it possesses it is probably in an earlier stage of evolution than is our own Sidereal Universe.

The exquisite photographs of the Magellanic Clouds suggest that each of these two gigantic systems is an independent double-spiral Sidereal universe, for spread through each of them we have star clusters, double, and wonder stars, just as in the belt of the Milky Way. Their appearance suggests that they are not much more distant than some parts of the Milky Way itself. Hence, they may at one time have been subsidiary parts of our great Stellar system. The Pleiades also seem to be somewhat independent in character, both from their position as well as their appearance, as shown in Figure 3. There are other minor systems that also suggest independence. Every star in the entire heavens seems to be moving. The name Proper Motion is given to this independent travel of the stars. It seems to have a mean value of something less than twenty miles a second, but some of the stars rise to speeds of some hundreds of miles a second: "runaway stars" these are sometimes called.

The motion of the stars is not indiscriminate; most of the stars appear to be moving in two stately processions in opposite directions. The distances they are apart are so enormous as to suggest that they do not often collide, but impact is undoubtedly a law of nature, and a surprising number of agencies have already been found that, in spite of the enormous distance of the stars from one another, must tend to produce impact. In addition to these two stately streams a number of minor drifts occur. This, then, is roughly the character of our Sidereal Universe. It will now be our task to attempt to show the mode of its origin. I speak of it as an attempt, but it is more of the character of an induction that has been demonstrated to be true by the fulfilment of endless anticipations based on dynamical deductions. The able mathematician Gifford says: "It has many of its predictions verified by subsequent discoveries in a manner as striking even as the fulfilment of the predictions of Mendelieff, based on the periodic law."

THE ORIGIN OF THE GALACTIC UNIVERSE.

The character of the Milky Way, as seen in the Southern Hemisphere, is much more suggestive of the mode of its origin than the portion we can see here in England. A centrifugal tendency is most strikingly exhibited. Lateral streamers seem to travel away from the main drift, suggesting the sprays of splashes left by a twirling mop.

It was in the Southern Hemisphere that, probably for this reason, some thirty-two years ago, a study of a beautifully clear sky suggested that the Milky Way was the result of the whirling coalescence of two previously existing independent cosmic systems. A careful study of Proctor's book on "The Universe" aided by Sidney Walter's exquisitely coloured charts of the two hemispheres, quickly convinced me that the induction was right; and every discovery made by astronomers since that time has tended to strengthen the conviction, and nothing more strikingly than the concluding remarks of Professor Kapteyn, before the Dutch Science Congress, on the Cosmic Cycle, which are quoted in the last section of this article.

THE DYNAMICS OF COALESCING COSMIC SYSTEMS.

Let us try and imagine the dynamical conditions that could bring about a configuration and distribution of material similar to the contrasted system that forms the Galactic Universe.

Later on in this article, the mode of formation of primordial cosmic systems will be described. It is deduced that they must consist chiefly of the lighter elements, taken by the high kinetol of the atoms out of cosmic systems. Through this primordial matter denser material is somewhat sparsely distributed. We have already seen there is a continuous tendency during the whole existence of Sidereal systems for light elements to be expelled. The many different processes are debated in the article of the September number of *Harper's Magazine*, "On the Cycle of the Eternal Heavens." They are also discussed in some fulness in the "Birth of Worlds and Systems," Harper's Library of Living Thought. Hence decadent cosmic systems tend to consist of compact suns, chiefly of heavy elements. Many of these bodies are dark stars, commonly known as dead suns. Thus we have two classes of cosmic systems, the incipient ones, consisting chiefly of light gas, and the decadent, consisting largely of compact masses of heavy elements.

Imagine two such systems to have come within the sphere of one another's attractions. Lateral attractions would prevent the encounter being quite centre to centre. Thus it is a case of whirling coalescence. As the two systems close in, the one upon the other, an immense friction ensues. The mutual attraction of the advancing suns, aided by this resistance, would cause collisions; a vast central furnace would thus grow up. The field of collision must for ages have gone on increasing both in density and dimensions. The furnace is walled around by the advancing material in all directions in the plane of impact. Presently, as temperature and density increase, the pressure becomes enormous. This explosive matter can find no relief in the plane of impact, for, as already shown, the material of the two vast systems is crowding in all around it and walling it in. But axially there is a chance of escape. The material is ejected towards both poles, and this action goes on

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increasing in intensity for ages, as the vast masses of the two systems continue to crowd in upon one another. In my early paper the name "axial extrusion" was given to this dynamical action. as we have said, in the opinion of Sir David Gill, is a system of similar order to our Milky Way.

It should be understood that even in the case of whirling coalescence the central portion is the third

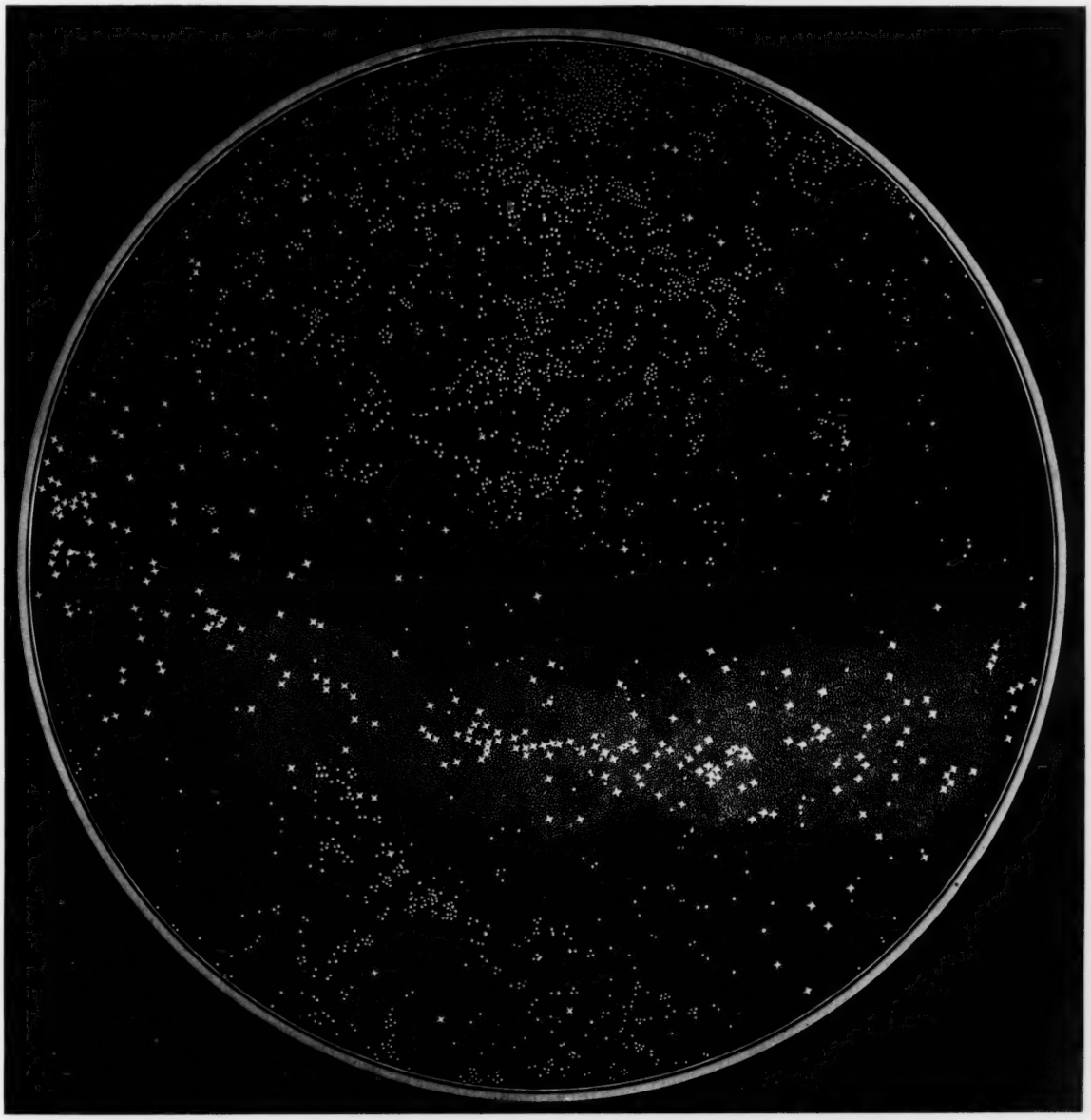

FIGURE 1.

The White Nebulae, largely double spiral, and Clusters in the Northern Hemisphere, plotted on equal surface-projection by Mr. Sidney Walters, from Sir John Herschel's catalogue. The Nebulae are represented by dots, the Star Clusters by crosses. In this same belt are temporary, variable, double, and Wolf-Rayet stars. This belt is the Milky Way, it contains the bulk of ordinary stars. Identically the same general distribution exists in the Southern Hemisphere.

Presently such an enormous quantity of material has been expelled that the capturing power of the third body diminishes. Selective molecular escape expels still more material, and the great central furnace begins to burn itself out. This seems to be the state of the great Nebula of Andromeda, which, body formed by the two coalescing portions. It possesses the thermodynamic intensity, and possesses also the capturing power. When axial extrusion occurs it may be pointed out that the capturing power diminishes, as it does in the formation of the orbits of a double star.

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Presently the capturing power of the third body lessens so much that the central attraction almost ceases, and the walling-in material is now urged forward by its own onward velocity. The onward motion takes it away from the centre, and the great furnace being no longer fed will soon have quite burnt itself out. Notice that after pressure ceases to expel material, atomic kinetol will continue to carry away molecules of low weight. This tangential motion carries the material forward in the mode described in the case of double spiral nebulae. The great Milky Way thus gradually spreads itself to the vast dimensions to which it has attained. The dimensions of cosmic systems appear always to be of enormous areas, and consequently the great central furnace would probably occupy but a small ratio of the whole. The two vast systems would be proceeding onward, in opposite directions, outside of the sphere of central influence, and it is this continued original motion that gives us the two majestic streams of stars whose existence has been demonstrated by a number of independent workers.

FIGURE 2.

Diagram—oblique view—of the constitution of the Galactic System. It is made up of three parts:—

I.—A vast double spiral ring of stars. In this belt the dots represent the star clusters, the temporary, variable, double, and Wolf-Rayet stars and planetary nebulae, these last being gaseous. The vast irregular nebulae such as that of Orion are also here.

II and III.—The two polar caps of the same System, mainly composed of White Nebulae with, as a rule, continuous spectra. These are largely double spirals, as shown in the diagram.

It is probable that every body and system in the universe possesses more or less rotation, and the old cosmic system that, by interpenetrating the primordial, went to the making up of our virile universe, most probably had a rotation of its own; this rotation would continue even during the impact, and it is almost certainly a continuance of this motion that is seen in those great streams of stars that called my attention to the probable origin of the Galactic Universe. There is one very definite principle of impact. It is that all motion developed during the collision tends to regularity, and all previously existing motions tend to disturb this order.

SUMMARY.

This, then, appears to be the mode of origin of the Sidereal Universe. Two cosmic systems of vast dimensions, one primordial and the other mature or decaying, approached one another, drawn together by mutual attraction. They obliquely interpenetrated one another and produced a vast central furnace, from which were expelled the extensive caps of nebulae that now clothe the two polar regions of our sidereal system. This axial extrusion, and selective escape, caused the central furnace to burn itself out; the released centrifugal force carried the walling-in material, stars and so on, to vast distances in space, and formed the Milky Way. In this Milky Way the opposite procession of the two streams of stars, aided by attraction and other agencies, caused collisions of dead and vivid suns, and these collisions produced, as already described, temporary, variable, double, and Wolf-Rayet stars, planetary nebulae and star clusters. The whole of these bodies represent the wreckage of colliding suns, and are all found wherever stars crowd and probably collide. Because these impacts possess such a wonderful building power this theory of impact is sometimes called "the principle of constructive collision."

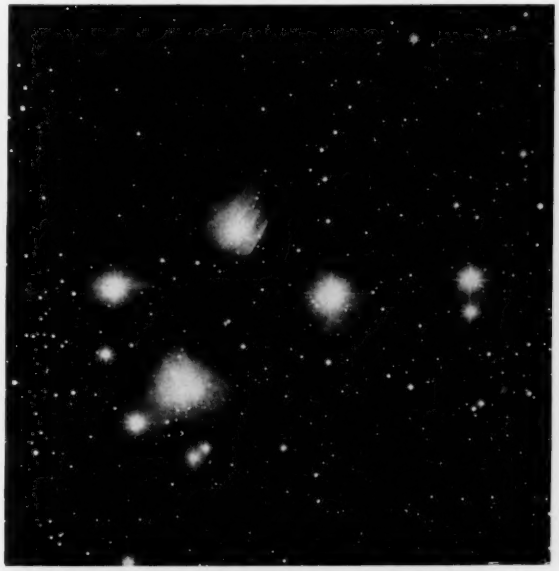
The above sketch shows how remarkably the actual facts of the order of distribution of the Universe correspond with the dynamical deduction made so many years ago. It must be remembered that the most strikingly confirmatory facts are discoveries made many years after the deductions were worked out. Some of the more convincing and sensational of these will be better understood when we have studied the agencies that show the possibilities of an Immortal Cosmos, agencies that Lord Kelvin overlooked when he, in founding his doctrine of dissipation of energy, looked upon this principle of degradation and death as applicable to the Cosmic Whole.

AN IMMORTAL COSMOS.

DISSIPATION OF ENERGY.

On this Earth, and apparently in the Solar system, there seems no possibility of perpetual motion. Coal burns, steam is produced, electricity is generated, cars travel, rooms are warmed, and light appears. But as the outcome of it all, low

temperature heat is almost entirely the final result. To get energy out of heat, there must be what is called a refrigerator, in order that this fall of temperature may partly be converted into motion of mass. This motion of mass will do work, and the work changes the motion of mass into motion of molecule, and this into the vibration of the trembling ether. So again the volume of the Sun diminishes and the pressure is increased. The fall of the molecules towards the centre makes them move faster and so the general temperature of the Sun is increased. But vast quantities of this augmented heat are poured out in a ceaseless flow of radiation, some of which falls upon the planets to be radiated again into space, but most of it speeds outwards in all directions in an apparent prodigality of waste that philosophically appears to be surprising. It is the general idea that this falls partly upon the dust of space and is partly sent to almost infinitely distant regions. We get from all these ideas Lord Kelvin's theory of dissipated energy, which the Germans call "warm death."



From a photograph FIGURE 3. *by Isaac Roberts.*

Nebulae in the Pleiades, December 8th, 1888.

Yerkes Observatory FIGURE 4. *October 19th, 1901.*

Great Nebula in Orion.

AGGREGATION OF MATTER.

On the other hand matter tends to aggregate. Suns are of all ages, incipient, young, mature, aged, and dead. A pair of dead suns in coming into complete collision become vivid again, and their luminosity may last a hundred million years, but this period is a mere breath in eternity. They again die, and may again live by another collision. Is this rolling up to go on until the entire contents of the great celestial vault is one huge dead cinder? all the matter of the Universe collected into one lifeless globe, and all the energy of the Universe dispersed into endless space? Such was the opinion firmly held some fifty years ago, and it continued to be held for fully a quarter of a century. Then chinks began to appear in the walls of this dismal dungeon of thought, and a little light has entered. Although official science still refuses to use this hopeful light, average humanity never quite entered the dungeon, and many minds now stand in the full light of the optimistic thought of a scheme of creation, infinite, eternal and flawless.

TWO NEW AGENCIES.

We have to ask: Are there agencies that in addition to concentrating matter, can distribute it; in addition to degrading energy, can elevate it. Certainly there appear to be such agencies. The collisions of suns can scarcely ever be directly centre to centre; every law of cosmic motion tends to make the orbits of colliding suns into curves, and no pair of bodies that are moving in independent orbits can possibly collide directly centre to centre. Hence oblique impact must be the cosmic law. These grazing impacts have already been shown to take place with such stupendous speed that the partial impact cannot stop the stars. A third body is produced. If the graze be of a small ratio, this third body will form an independent star of such supreme power, so stupendously hot, as to be thermodynamically unstable, and to blow itself to isolated atoms. When the temperature of the mass becomes approximately uniform the kinetol of the

light elements becomes so excessive, that they escape not merely the new star, but the influence of the three stars. A high-velocity atom escapes the very cosmic system of which it is a part, and wanders away to the empty parts of space. All the while it is doing work against the gravitation of the cosmic system it is escaping from, and it will linger in the portions of space where there is a minimum of matter. Thus is matter distributed. Sometimes again three stars approach one another and in the manner described in "The Birth of Worlds and Systems" one of the three may acquire a speed of sufficient power to project it beyond the limits of the cosmic system of which it is a member. There are other agencies by which material is carried out of systems, so that the process of rolling up of suns into bigger and bigger suns is not the only mode of the mechanism of the universe. Just as we saw that impact is not a random, chance, or accidental occurrence, but a definite law of nature, do not these distributing agencies show that there is a law tending to a constant rough equality in the distribution of matter?

ELEVATION OF DEGRADED ENERGY.

It is now our task to ascertain if any law exists by which the degraded energy that we call low temperature heat, can be raised into that highest form of energy which is known as the potential energy of separated gravitational masses. What becomes of this torrent of vibratory energy that is pouring out from the hundred million suns of our system? It probably travels to enormous distances; it is exceedingly likely that it will ultimately fall on the dust of space and warm it, and, if there were no other agencies, give us the condition that Kelvin deduced, and the Germans named "warm death." But another exceedingly complex series of factors must apparently be brought into play. Bodies, whether dense masses or isolated light atoms, when not entrapped into orbits must occupy but very little time at high velocity. As the speed grows less the duration grows greater, until when nearly at rest they must occupy durations that are almost immeasurable. Now a particle of gas at rest is at absolute zero. So that much of the free molecular matter of space must be very cold, as it is moving slowly. A slowly moving particle of helium or hydrogen coming in contact with a warm particle of cosmic dust will acquire its temperature, and this heat will become molecular motion, and the molecule will leave the particle with an increased velocity. This increased velocity will cause it to travel away, often in the direction that will convert its atomic motion into potential energy of gravitation. Coming nearly to rest again the process will be repeated, until, as a final result, the molecule will wander until it reaches the position of high potential in space, where it will necessarily linger longer than anywhere else.

ANOTHER AGGREGATING AGENCY BESIDES GRAVITATION.

In a position where bodies moving indiscriminately linger longest, there they tend to accumulate. In 1879, when this principle was first detected, it was called the Aggregating Power of the Position of High Potential. This principle, which no mathematician has ever disputed, and which one of our ablest has called "a mathematical *vera causa*," shows us that we have a second aggregating tendency in nature in addition to gravitation. Do we not again perceive another law of nature tending to elevate degraded energy so that it shall be perpetually available for the purposes of life eternal? Do not these three laws of nature, added to our former knowledge, show us a cosmos infinite and deathless? First we have the set of agencies that produces the constructive impact of cosmic bodies and systems; then the one that tends to distribute as well as aggregate matter; and, lastly, this complex series of agencies, made up of the high kinetol of light atoms, the elevation of degraded energy, and the aggregating power of the position of high potential. The whole gives us a series of wonderful laws of nature that, together, present us with the possibilities of an immortal cosmos of infinite extension and perfection of design.

THE THEORY A DEMONSTRATED DEDUCTION.

Finally comes the question: Is this beautiful optimistic picture of the Cosmic scheme a true one? Grant grazing impact and, as Sir David Gill has stated, the idea of the formation of the third body is true. When we consider the dozen agencies that tend to produce impact we cannot doubt its happening. Even did we, without evidence, doubt, when we consider the coincidence between deduction and observation every trace of doubt absolutely disappears. It is quite certain that Nova Persei was the third body produced by the graze of suns. Every thermodynamical, chemical and physical deduction made thirty-three years ago, has been confirmed. Sudden appearance, rapid increase in brilliancy, quick disappearance, all agree. Every character of the abnormal light curve agrees. Every one of the series of complex spectra tells the tale of the physical changes of nucleus and ensphering shells in exquisite minuteness of corresponding detail. The star, as was deduced, passed into the planetary nebula stage. Any one of these striking confirmations, in the absence of opposing evidence, would suffice for a demonstration. What shall we say when we think of the fact that the several different series all correspond in each and in every step?

NOVAE DEMONSTRATED TO BE THIRD BODIES.

Hence, emphatically, Nova Persei was a third body, and as all novae are so typically alike in their many characteristics, we must infer that all novae are the exploding third bodies struck from grazing suns.

Then take the mass of evidence that variable and double stars are the torn suns, and again how overwhelming is the evidence. Every deduced salient physical feature has a representative in fact, often in a multiplicity of confirming facts. Why should

variables be in pairs? Why should binaries be variable and often doubly variable? In each case the probability against chance runs into sextillions. Why are they associated with nebulae? Consider again the form and character of nebulae. Why should the spirals be always double? Why are the planetary nebulae often sphere in sphere and have centres exactly as deduced? Why should double spiral nebulae be amongst nebulae where stars are scarce, save that, as deduced, they are formed by the impact of nebulae? Why should the planetary nebulae be where the stars are thick, clearly because, as deduced, they are produced by the impact of stars? Are not the temporary variable, double, and Wolf-Rayet stars also where stars are thick? Is not the answer obvious, because, where stars are thick, there will be a maximum of stellar collisions, and all these kind of stars are deduced as the offspring of stellar collisions.

THE DUAL CHARACTER OF THE GALAXY DEMONSTRATED.

Then, when we come to the Galaxy, what other conception is possible that could produce such a marvellous and singular set of contrasts and correspondences, but the impact of two formerly independent stellar systems? Here Professor Kapteyn's demonstrations are all-important. He concludes his magnificent address to the Dutch Science Congress in the following words:—"The stellar system was not originally a single system in which the two known drifts or currents have developed; but the present system is the result of the encounter of two systems which originally were entirely independent of each other.

The primordial matter is now more abundant in the drift of less star-density, and is almost entirely absent from the opposite drift, which is richer in stars."

Clearly in this primordial material we have the cosmic system of the first order that a study of natural law has shown must grow up in the unoccupied parts of space, and the other constituent is clearly a stellar system of greater maturity.

Surely such a fertile generalization should be used as a working hypothesis to guide research, and that at once. If it is true as able thinkers say that the neglect to use it in the past has retarded astronomy a decade, all haste should be made that the several threads suggested should be followed and woven into a fabric in which every thread has its allotted place and purpose; so that this glorious science, astronomy, instead of being a mere chaos of facts, instead of apparently pointing to eternal death, shall show itself to be a consistent system of creation without evidence of a beginning or promise of an end, infinite and flawless.

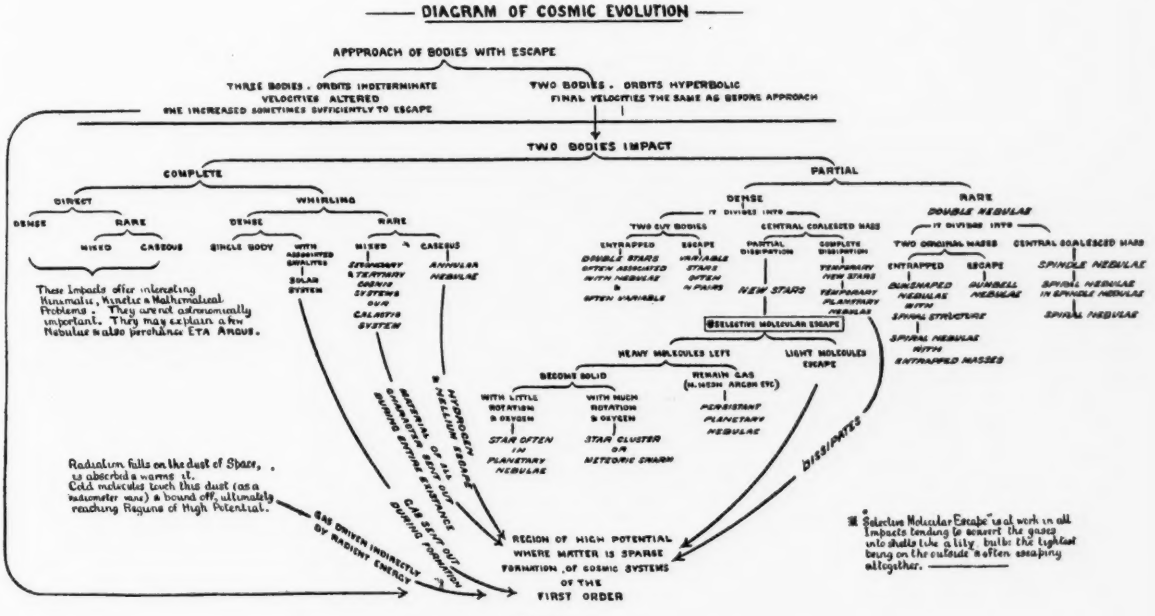


DIAGRAM OF COSMIC EVOLUTION
APPPROACH OF BODIES WITH ESCAPE
THREE BODIES. ORBITS INDETERMINATE
VELOCITIES ALTERED
ONE INCREASED SOMETIMES SUFFICIENTLY TO ESCAPE
TWO BODIES. ORBITS HYPERBOLIC
FINAL VELOCITIES THE SAME AS BEFORE APPROACH
TWO BODIES IMPACT
COMPLETE
PARTIAL
DIRECT
WHIRLING
DENSE
RARE
MIXED
CASEOUS
SINGLE BODY
WITH ASSOCIATED SATELLITES
SOLAR SYSTEM
ANNULAR NEBULAE
These Impacts offer interesting Kinematic, Kinetic & Mathematical Problems. They are not astronomically important. They may explain a few Nebulae & also perchance ETA ARGUS.
ENTRAPPED
ESCAPE
DOUBLE STARS
VARIABLE STARS
NEW STARS
SELECTIVE MOLECULAR ESCAPE
HEAVY MOLECULES LEFT
LIGHT MOLECULES ESCAPE
BECOME SOLID
REMAIN GAS (H, HELIUM ARGON ETC)
WITH LITTLE ROTATION & OXYGEN
WITH MUCH ROTATION & OXYGEN
STAR OFTEN IN PLANETARY NEBULAE
STAR CLUSTER OR METEORIC SWARM
PERSISTENT PLANETARY NEBULAE
DOUBLE NEBULAE
TWO ORIGINAL MASSES
CENTRAL COALESCED MASS
SPINDLE NEBULAE
SPIRAL NEBULAE IN SPINDLE NEBULAE
SPIRAL NEBULAE
DUMBELL NEBULAE
SPIRAL STRUCTURE
SPIRAL NEBULAE WITH ENTRAPPED MASSES
HYDROGEN & HELIUM ESCAPE
DISSIPATES
Radiation falls on the dust of Space, is absorbed & warms it. Cold molecules touch this dust (as a radiometer vane) & bound off, ultimately reaching Regions of High Potential.
GAS DRIVEN INDIRECTLY BY RADIENT ENERGY
GAS SLOWLY OUT DURING FORMATION
REGION OF HIGH POTENTIAL WHERE MATTER IS SPARSE
FORMATION OF COSMIC SYSTEMS OF THE FIRST ORDER
"Selective Molecular Escape" is at work in all Impacts tending to concert the gases into shells like a lily bulb the lightest being on the outside often escaping altogether.

FIGURE 5.

Diagram taken from Professor Bickerton's "Romance of the Heavens," 1900.

Kapteyn, by summing up his own theory, Greenwich and others' observation, has now satisfied himself that our Galactic Universe is made up of two interpenetrating systems, one of them primordial, that is of the first order, as shown to be forming below the centre of the diagram.

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FIGURE 1. The Cameras and methods of illumination.

THE PROCESS BLOCK.

By H. E. REA.

PROCESS blocks are used now for printing illustrations in all sorts of periodicals—in the halfpenny newspaper, as well as in the finest book or art catalogue.

A block must be made capable of printing side by side with type, and it must be able to give all the range of tones of the original from black to white. It is made to do this by having its surface cut up into a very large number of "dots" or squares—so small as to be, as a general rule, unnoticed by the naked eye—which catch the ink when the roller goes over them and which immediately afterwards print the picture.

The block-maker has first to consider—when he gets the photograph or drawing which is to be reproduced—what sort of paper the block is to be used upon, whether rough or with a smooth surface, or art paper. The better the paper is, the greater is the number of "dots" which can be made and the closer they will be together. The original is then pinned up on the copying-board (see Figure 1), which is illuminated by two powerful arc lamps, and a photograph is taken of it, which may reduce or enlarge it, according to the size of the block wanted, and which, at the same time, brings the "dots" into existence. This photograph may be taken by means of the wet collodion process, the collodion emulsion process or on a dry plate. In the first two cases the operator has to prepare his own plates, but dry plates made especially for process-workers can be obtained from the dealers. The writer uses dry plates.

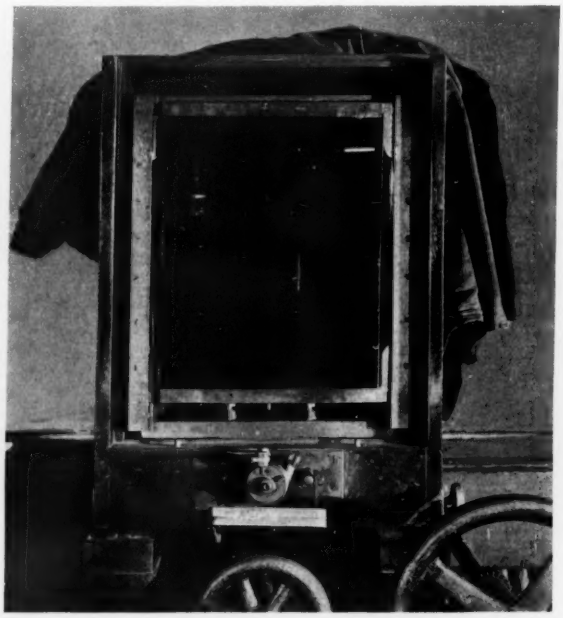

FIGURE 2. The Camera with the screen in position.

The "dots" are obtained by interposing in the camera, between the photographic plate and the lens,

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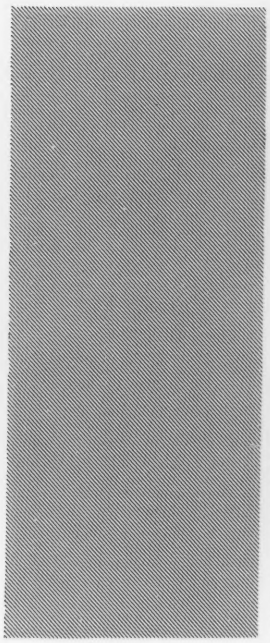

FIGURE 3.

One half of the screen.

FIGURE 4. The dots enlarged from a screen negative.

If this picture is held at a distance from the eye the effect of the photograph will be seen. It is part of Figure 10.

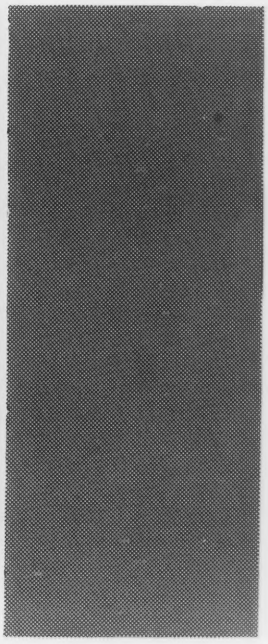

FIGURE 5.

The cross lines of the screen.

a ruled screen (see Figure 2), which is made by having two diagonally-ruled glass plates sealed together — the result being a cross-lined mesh (see Figure 5). The image passing through this gets cut up into a series of dots and squares —ranging gradually from fine black dots in the transparent parts of the negative to squares in the half-tones and transparent dots in the high

FIGURE 6. Printing.

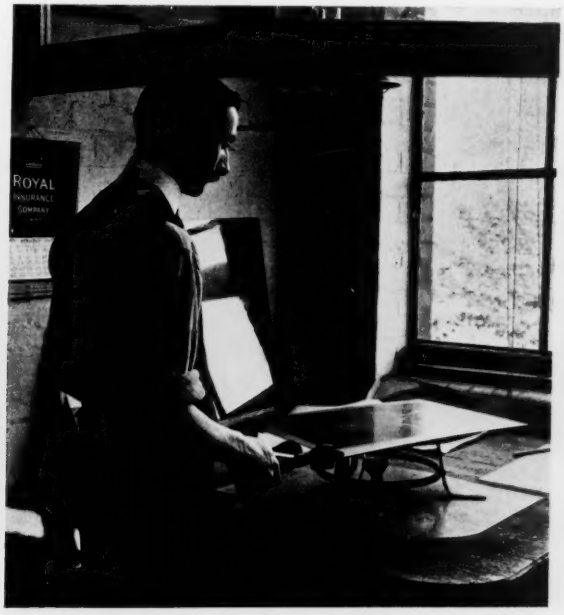

FIGURE 7. Firing the Plate.

XUM

lights. The mesh of the screens varies much—ranging from fifty lines to the inch for very heavy or rough printing to four hundred lines to the inch for the most careful and finest art printing. The most useful screens have one hundred and twenty, one hundred and thirty-three and one hundred and fifty lines to the inch, and these are, as a general rule, the sizes used in connection with illustrations for magazines. In the case of the daily papers — which are very rapidly printed on fast-running machines — the illustrations require screens with a much more open mesh—usually of from seventy-five to one hundred lines to the inch. If the reader will examine one of the illustrations in this magazine under a strong magnifying glass he will see how the picture is formed by the "dots" and squares.

FIGURE 8. The Etching Bath.
Examining the plate for depth.

When the operator has adjusted the screen to the required distance from the plate—so as to give the kind of "dot" desired—he makes his first exposure, which is to give the "dot" formation in the darker parts of the subject. He then places the cap on the lens, puts in a larger stop and exposes again. He, in this way, gets a "dot" formation of the detail. The third exposure—with a still larger stop—is for the "dot" formation in the high lights (see enlarged illustration of the screen effect in Figure 4). Some operators make only two exposures. The different stops used vary a great deal. Some operators favour one kind — others another. The writer uses three kinds—a very small one to give the "dots" in the blacks, one about three times as big to give the detail, and a square one, about three times the size of the one last mentioned, for the high lights. The exposures are very short—whichever of these stops are used. Their whole aggregate length—from

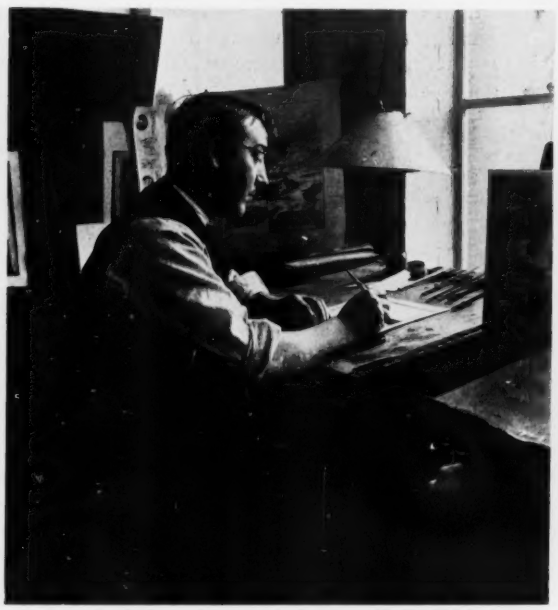

FIGURE 9. A Fine Etcher at Work.
"Stopping out."

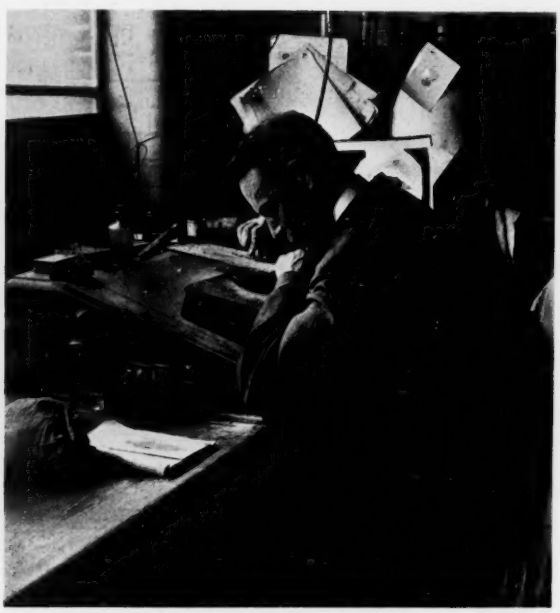

FIGURE 10. Engraving the Plate.
"Taking out blemishes."

the beginning of the first till the end of the third—varies from a minute and a half to three minutes if an arc lamp of the enclosed type is used, as this gives the greater percentage of violet or active rays of light, to which the plates are most sensitive. The exposure with the open type of arc lamp is about three times as long

The exposed plate is now developed in the ordinary way, and it is afterwards reduced (in density), or, to use a trade term, "cut in," by letting a solution which diminishes the size of the "dots" flow over it. This is done until the "dots" are of the size necessary to give the requisite brightness.

The object of the burning or baking is to make the coating into a hard enamel.

The plate is now passed on to the etchers, who place it in a solution of perchloride of iron. This eats away the copper between the dots, and thus leaves the image standing up in relief, the enamel not allowing the solution to touch the "dots." A rough proof is now taken of the print in order to see what further etching is required. This fine etching (see Figure 9) is done by stopping out, with a resisting varnish, parts which do not require any further etching, and the high lights are then etched up so as to give more brightness and detail.

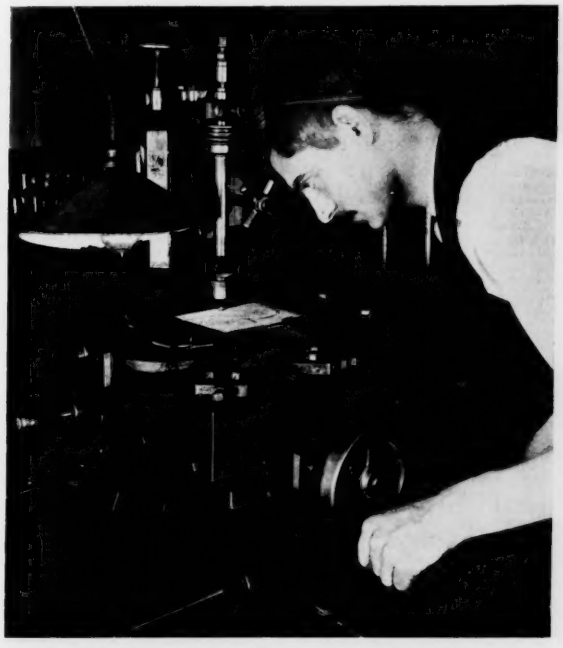

FIGURE 11. Routing away useless metal.
By using the two handles the router can be made to go in any direction desired.

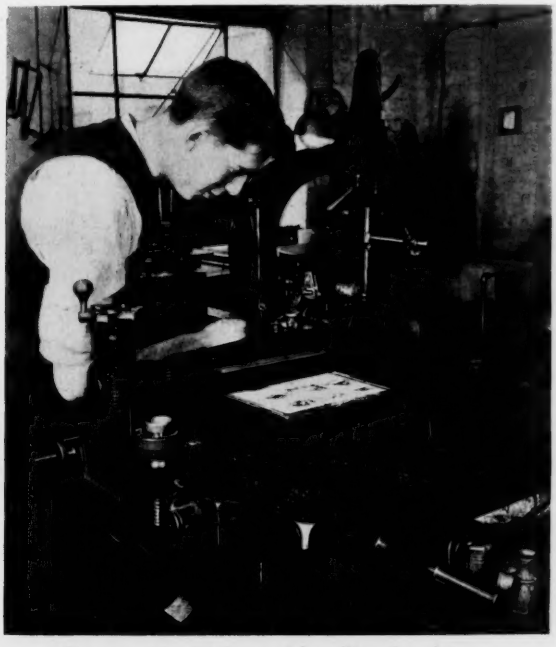

FIGURE 12. Lining and bevelling the plate.
In this way it is got ready for nailing on to the wood when it will be type-high.

The finished negative is now dried and given to the printer. After he has examined it to see how long it will take to print, he places it in contact with a piece of copper, which has been made sensitive to light—both being put into a printing frame, which enables great pressure to be exerted to bring the two close together. The piece of copper is sensitized with a solution, composed of white of egg, fish glue and bichromate of ammonium. The frame is put in front of a strong light, which, acting on the sensitized copper through the transparent parts of the negative, prints the image on to it. The print on the copper plate is then developed in water, which dissolves away the solution not acted upon by the light, and it is afterwards burnt in over a Bunsen burner (see Figure 7). The result is a print made up of a series of "dots" and squares, ranging from fine white "dots" in the blacks to fine black "dots" in the lightest parts of the subject.

When the etchers have done all that is necessary the plate is then passed on to the engravers (see Figure 10), who take out unnecessary spots and engrave up what lights require brightening or what darks require a little burnishing so as to give a greater depth of colour.

The block—as it may now be called—is now ready for the finished proof to be taken, and after that is done it is given to the mounter, who fastens it on to wood of such a depth as to make it as high as type. It can now be printed side by side with type.

The methods of working and the apparatus used have, within the last few years, been brought to such perfection that it is now possible for a block to be completely made—ready to be put on the printing press—within one hour from the time the photograph or drawing is placed in the operator's hands. This, of course, is only for a hurried illustration; the usual time taken over a block is from four to five hours.

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A SCANDINAVIAN TRIBE IN THE ARCTIC NORTH-WEST.

By COMYNS BEAUMONT.

THE "new" race of Arctic men which Herr Villijmar Stefanssen, the leader of the American Museums' Scientific Expedition, has discovered in the Arctic regions north of British Columbia, provides an invaluable link in the chain of evidence which the advanced school of ethnology is forging.

Herr Stefanssen is astonished to find that this race of men are Scandinavian in appearance. Everyone asks how can it be? Students of Polar research, at a loss to interpret the phenomenon, wonderingly suggest that the men are descendants of the crews in Sir John Franklin's expedition, who had inter-married with the Eskimos. If this were so, in such a comparatively short period these men would be able to make their identity clear. In less than one hundred years men belonging to a virile race do not lose their language, their customs, or forget the fatherland. Indeed, it requires immense periods for colonisers or emigrants to change their language, to forget their national customs and to allow their earlier history to pass into myth or legend.

Stefanssen as yet has given us few particulars respecting these Polar Scandinavians, excepting that two of the men had red beards and that they were markedly European in type.

If the description, meagre though it be, proves correct, they should be a remnant cut off from the great Scythian family, and as such can have no relationship whatsoever with the Eskimo, who belong to the same family as the African Bushmen.

Who were the Scythians? What limit may be imposed on their ramifications? If these two questions may be answered, a solution will probably be found to the mystery of Scandinavian types in the Arctic north-west. The Scythians were people of fair complexion, blue or light eyes, with flaxen brown or red hair and of strong physical build. From the remotest times they descended from the north, a people possessing a restless unconquered spirit, apt to take fire at the very mention of subjection and restraint, and overrunning the globe in more than one continent. The Scandinavians, or Goths, were Scythians.

There is no vaguer term in ancient geography than Scythia. Blackwell, the editor of Mallet's "Northern Antiquities," says that it would embrace all the countries lying between the river Don in the west, the great desert of Gobi in the east, the Hindoo Koosh mountains in the south, and the plains of Siberia in the north, "in which direction the boundaries might be limited or extended to suit any particular theory, being for the ancients *terra incognita*." But the original name of the Scythians extended over a much wider field than Blackwell considers adequate. We find undoubted Scythian traces in America. Major P. H. Fawcett, F.R.G.S., has collected evidence, hard to dispel, of a race of white people with red hair in the hinterland of Brazil. Short, in his "North Americans of Antiquity," confesses that the standing puzzle to ethnologists is the wide range of colour and complexion found among the American Indians. The Menominee, Dakota, Mandan, Allegheni and Zuni tribes, among others, very often possess auburn hair, blue eyes and white skins. Who were the famous Chichimecs of American legendry? The Chichimecs entered Mexico from the north; they came from "Amaquemecan," a "land of vast extent"; their titular deity was Votan, or Odon, whom the erudite Humboldt was astonished to find corresponded in every particular with the Wodan, or Odin, of the Scythian nations; this Votan (also called Odin, or Oton) was a white man, with a long beard, attired in white garments bearing the insignia of the Cross in red. The ancient and mythical capital of this people preserved in records like the Popol Vuh, was a city called Tula, Tulan or Tulla. The Popol Vuh tells us that Tula was bitterly cold; for instance, Part III, Chap. V, verse 5, says: "But then began a great rain that extinguished the fire of the tribes and much snow fell on the head of all the tribes and their fire was extinguished then because of the snow; there was no more of this fire which had been made." And verse 8: "And they were able to do nothing because of the cold and of the ice, trembling (as they were all) and chattering their teeth the one against the other, having no more life in them, feet and hands benumbed, to the point that they could no longer hold anything." It must be remembered that the Popol Vuh is the equivalent of the Pentateuch among the Quiché people, who were, like the Hebrews, wanderers for long periods over large extents of territory, and who, like them, were enslaved by a Pharaoh through whose country they passed. The people who enslaved them were the Chichimecs. Another deity of the Chichimecs was Toras, whose name and character closely resemble the Scandinavian Thor.

At a comparatively recent date, even as records go (opposed to legend), there is no doubt that the

northern portions of the world were much more closely linked together than is the case to-day, and that the adventurous peoples from the northern parts of Europe were not uncommonly accustomed to make voyages to Greenland and Northern America, owing to an almost continuous land connection. In the Icelandic sagas, that part of America embracing Texas, Florida, the valley of the Mississippi, Georgia and the Carolinas was designated under the name of Ireland-ik-Mikla, or Great Ireland, and was considered to be a land of white men. (See Beauvais, "Decouvertes des Scandinaves en Amerique.")

We have, then, undoubted traces of Teutonic, or Scythian, descent in America; the same race over-ran the north of Asia and Europe; tucked away in a corner of the Arctic regions is a small tribe of apparent Teutonic characteristics. Were the Scythian peoples always unsettled, always wanderers over the north, or is there some truth in the Chichimec legend that they inhabited Amaquemecan, "a land of vast extent"?

What does the geology of the Arctic regions teach us?

There was a period when lands stretching across the Atlantic Ocean, and which linked up the Atlas range with the West Indies and Central America, were gradually breaking up. At this time the United States proper did not exist; its place was occupied by a brackish sea containing a number of islands; but in the northern portions of the Atlantic region definite evidence exists of the presence of dry land, while a good deal of modern Europe, North America and Asia were occupied by the ocean bed. Certain flora of the Tertiary period, covered by basalt, occur in County Antrim; the same flora—*Taxodium distichum*—has left deposits in lignite in Spitzbergen, Ireland, the Hebrides, the Faröe Islands, Iceland, Greenland, and even beyond; Fielden found Tertiary plants in British Columbia containing examples belonging to Mexico and the South, and the existence of this flora, says Professor Suess, "has been frequently regarded as a proof of the existence of a great continent, richly covered with vegetation, which occupied the site of the present North Atlantic Ocean."*

Elsewhere† in his magnificent work, Suess points out that the Tertiary land faunas of North America correspond with those of Europe, demonstrating clearly that a once vast northern area definitely connected, has been broken up, of which parts disappeared. This reconstruction of lost Hyperborean lands is, curiously enough, borne out by the celebrated map of America added to the edition of Ptolemy's Geography, which showed not only Greenland and Newfoundland, but separated the north entirely from the American Continent, and carried this northern land across until it united with the north of Asia.

The Greeks and Romans preserved lively recollections in their mythology of this great Hyperborean Continent, situate far to the north-west, and which enjoyed a mild and beneficent climate. It was the Saturnian Continent, where Saturn, Hercules and Apollo were honoured. Thence Hercules led an expedition whose first destination was to such a northerly clime that, according to Plutarch, during thirty days the sun set for only one hour, and even during that time a twilight reigned. Ogygia was distant further still, where Saturn slept in a deep cave where he had been placed by Jupiter. Indeed, the trend of opinion to-day is gradually coming round to believe that the Hellenes themselves originated in this part of the world, and that their heroic stories refer to that early period of flux when the Scythian peoples lived in the regions now given over to the iceberg.

Without question there was a period, not geologically far removed from our time, when the Polar regions rejoiced in a soft and beautiful climate. It used to be said that this was before man lived. Now, on the contrary, the weight of evidence indicates that man not only lived then, but that the north, as said the Goth Jornandes, was the forge of mankind. When the north enjoyed a beneficent climate, prior to events of the utmost magnitude which changed the entire climate of the world and altered the face of the earth, we cannot surely escape from the conviction that all the evidence is in favour of its being the original home of a great portion of the human race. We know that the earth has constantly shifted its axis, and by a study of the other planets we are enabled to foretell with some exactitude the result of any great change. The causes which lead to a shifting of the earth's axis need not be discussed here, but the effects must be considered. According to the esoteric belief of the ancients, including Plato, the planet Jupiter caused a world conflagration, and whether it did so or not, there is no question but that, prior to the Glacial Period, certain lands became submerged, which interfered with its equilibrium and caused the earth to shift its axis, owing to the change in its centre of gravity. "As the centre of gravity of the earth varied," said Major-General Drayson, F.R.A.S., in a paper read to the Royal Astronomical Society in 1896, "due to the elevation and depression of lands and the consequent transferal of hundreds of millions of tons of ocean water so must the centre of gravity of the earth have varied, and consequently the angle formed between the poles of daily and second rotation, and hence the climatic changes. . ."

The Glacial Age drove the Hyperboreans south. Thus began that period of enormous migrations among which the Israelites comprised but one small portion. Millions of people perished, and hence the universal Flood Story. But, as though it were by chance, here and there communities were isolated and spared. Some of these in turn sought more friendly climes, but others remained; and thus we have a rational and natural explanation of Herr Stefanssen's Scandinavian tribe in the Arctic regions of the north-west.

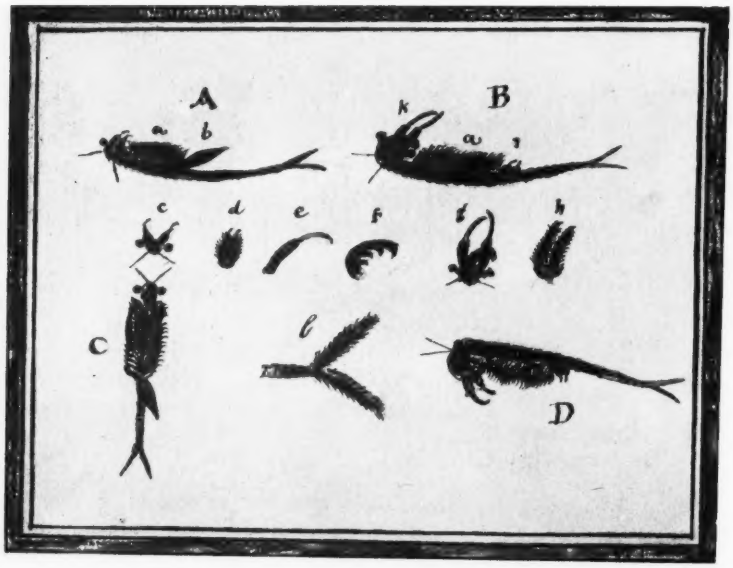
* "Face of the Earth," Vol. I, p. 287.

† Vol. I., p. 13.

XUM

J

A Description of a very remarkable Animalcule, found in a ditch of standing water, near Norwich, April, 1762.



A is the female, and B the male, both placed on their backs, in the posture in which they usually swim. a a are a number of small transparent fins, (much resembling the anatomical preparation of the pia mater,) placed parallel, and contiguous to each other; and which are almost always in motion; the animals seeming to keep themselves suspended in the water by means of them. d is one of those fins seen front ways, in the female, and h one of the same belonging to the male. c is the head of the female, and g that of the male, distinguished by three projecting substances like horns or tusks, which are marked k in the figure B: one of the long ones on the side is drawn seperate at g.

The above reproduction of a manuscript note is of interest in connection with our article on the occurrence of *Chirocephalus diaphanus* in "KNOWLEDGE" (Volume XXXIII, page 169). The page was discovered among a series of coloured drawings of Natural History objects, in the possession of Mr. Alexander Gordon, which apparently once belonged to Edward King, F.R.S., the Recorder of King's Lynn, whose father lived at Norwich. Edward King wrote chiefly on archaeology and religion, but also took some interest in natural history. In the original, which is reproduced by kind permission of Mr. Gordon, the lines are in red ink.

PLANT HAIRS.

By K. E. STYAN.

(*Continued from Page 430*).

PART VI.—(*a*) HAIRY AWNS AND (*b*) PAPPUSES. IN the great work of dissemination of fruits and seeds which is being carried on by various agencies, daily, over the length and breadth of the world, hairy outgrowths play a very important part; for they ensure the structures on which they spring being wind-wafted, whether or no they take the form of true coverings to the seed, "pappuses," or feathery, silky awns, or appendages. Usually the hairs found on seeds and fruits are extremely numerous, so numerous that it is quite out of the question to attempt to count them, but instances do occur in which only quite a limited number are present, of which one good example may be seen in the case of a plant called *Aeschynanthus*, whose fruit only bears *three* hairs on it, one on one side and two on the other. But these three are specially adapted for the great use to which they are called into being by being remarkably flexible, which not only causes them easily to adhere to, but also to curl round the wool or fur of animals after they have been wafted by the wind on to the creature's body. Thus the hairs in this case cause the fruits to be disseminated both by wind agency and animal conveyance.

Exquisitely beautiful are many of the hairy prolongations that are found. Our hedgerows in autumn are made charming by the presence of silvery clusters of wild clematis (see Figure 2), which is—most truly — a Traveller's Joy. Each tiny part of one of these clusters consists of a tiny fruit, called an achene, bearing a very, very slender, silky, hairy appendage, which is so light that the slightest puff of wind catching it when the fruit is ripe, enables the latter to be wafted away through the air like a bit of gossamer. Another lovely example may be seen in the grass *Stripa pennata* (see Figure 1), one that is often grown in gardens for decorative purposes. The fruit of this plant is an elongated, *very* sharp, needle-pointed achene, covered with short, soft, silky hairs, which are reflexed; from its upper end springs a slender, string-like stem that becomes cork-screwed for part of its length and then straight; above this portion rises a very long (often more than a foot in length) delicate hairy awn. In its own native haunts abroad these awns

FIGURE 1.
Awned achene of *Stripa pennata* (two-thirds natural size).

FIGURE 4.
Tip of hairy awn of *Geum palustris* (greatly enlarged).

FIGURE 2.
Awned achene of Traveller's Joy, *Clematis vitalba* (life size).

FIGURE 3.
Awned achene of Water Avens, *Geum palustris* (enlarged).

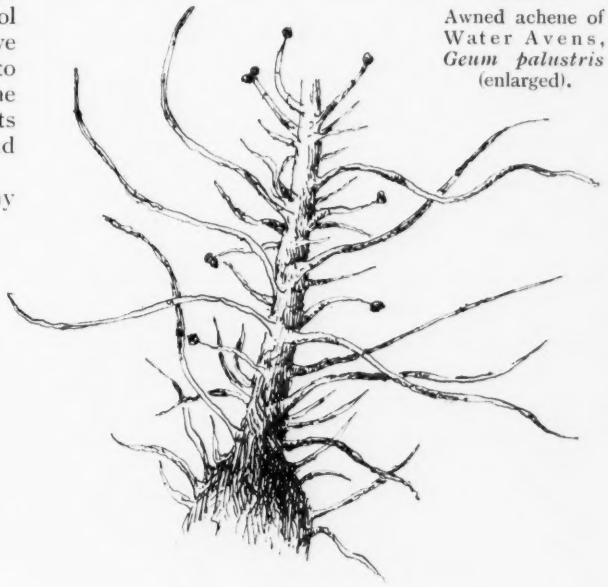


FIGURE 5.
Base of the hairy awn of *Geum palustris* (greatly enlarged).

catch the wind and bear the fruits miles and miles over dry, bare land, till some damper spot is reached, when, surrounded by herbage, which arrests the progress of the awn, and by the unwinding of the corkscrew owing to the moisture, the achene is forced into the ground by its sharp point and there produces a new plant. The Water Avens (*Geum palustris*) (see Figure 3) produces an awned fruit something like that of the Traveller's Joy, and the accompanying illustrations (Figures 4 and 5) show a series of magnified parts of the awn. The tip is slightly swollen and sticky, and along the sides, amidst the long, slender hairs, are some that are glandular. The stickiness of these may be another means by which the awn, after being carried by the wind, can adhere to any foreign body with which it may come into contact.

FIGURE 6. Pilose sessile pappus of Rough Hawkbit.

FIGURE 7. Plumose sessile pappus of Mouse-ear Hawkweed.

What are known as "pappuses" are the structures formed as "after-growths" from the calices of many plant-species as soon as the blossoms die and their fruits begin to ripen for dissemination. So light are they, even if stemmed, that the wind can carry them great distances; the faintest puff, and away flies the fairy "clock" or ball of silver "down," over meadow and hedge, away—far away—till it gets beyond our sight; or we may see the wind drifting over countless myriads of pappuses on some area of bog-land where the Cotton Sedge grows in rank luxuriance, swaying the snow-white hairy heads till they look like breaking wavelets, gleaming as they catch the glint of passing sunbeams. In this plant each pappus consists of a tuft of soft, long, slender white hairs encasing one tiny fruit.

Then, upon the Black Poplar tree, in early summer, or on the ground beneath it, we may see hairy catkins that look just like tiny lambs' tails. In reality these "tails" are only aggregations of satiny pappuses, each attached to a small seed.

Of all the natural orders, the Compositae show most pappus heads, indeed they abound in the species of Filago, Cud-weed, Groundsel, Hawk's-beard, Ragwort, Hawkweed, Hawkbit, Cornflower, Knapweed, Fleabane, Colt's-foot, Dandelion, and Goat's-beard. Figure 6 shows one separate pappus from Rough Hawkbit. This has the hairs springing from the achene *without* a stalk (hence is called sessile), and its slender hairs are unbranched, or "pilose." In the Mouse-ear Hawkweed (see Figure 7) the hairs are branched, or "plumose" as the botanical term is; and in Dandelion (Figure 8) they are unbranched but have a stem, and hence are said to be pilose, "stipitate."

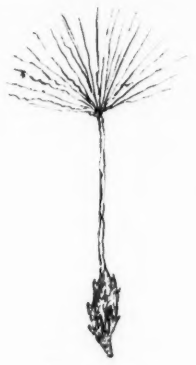


FIGURE 8. Pilose stipitate pappus of the Dandelion.

The largest and most beautiful of all English pappuses is that borne by the Goat's-Beard, one of the Compositae, in which each separate fruit has a mass of webbed hairs at the top of a long slender stalk, forming a miniature parachute; and the massing together of the many fruits into one head forms a large, silvery, hairy ball, that is one of the most exquisite structures one can ever wish to study in all the wide field of wild nature.

METEORIC SHOWER OF SEPTEMBER 30TH.

By W. F. DENNING, F.R.A.S.

IN the October number of "KNOWLEDGE," I gave some particulars of several fine meteors witnessed on September 2nd. There occurred a somewhat similar display on September 30th.

The night was beautifully clear, and offered an unusual exhibition of cometary as well as meteoric phenomena, for no less than three comets were visible to the naked eye—two in the evening, and one in the morning just before sunrise.

I watched for meteors for about one-and-a-half hours before midnight and saw sixteen, of which four were fairly conspicuous. Mr. Sidney Wilson and Mrs. Fiammetta Wilson, of Bexley Heath, saw thirteen meteors, and three of these were seen at Bristol.

A fireball brighter than Venus appeared at about 9.5, and it was observed by Mr. H. Corder, at Bridgwater. He says it gave a rather bright flash as it fell towards the western horizon, and disappeared behind the Quantock Hills. He only caught about 6° of the terminating portion of the flight, which was directed from α Herculis from about 3° above β Cygni.

The same (bluish-white) meteor was noticed by Mr. Joseph MacDermott, of Glasnevin, Dublin, who describes it as of twice the brightness of Jupiter as seen with the naked eye. Its observed position was a little S. of S.W., and it fell from about 30° to 15° of altitude in a direction from Pegasus.

A bright meteor was noticed by Miss Irene Warner, of Bristol, at 10.5, falling from about 28° + 35° to 14° + 15° and leaving a long red streak.

At 10.40, Mr. H. Denning saw a fireball descending in N. by W. He could not, however, exactly locate the place of the phenomenon as he saw it from Stokes Croft, Bristol, where there is a good deal of artificial illumination and obstruction by buildings.

At 11 o'clock Mrs. Warner witnessed a bright meteor from Horfield Common. It travelled slowly upwards from under Aldebaran to the planet Saturn and probably from a radiant in the southern part of Taurus. The following are the real paths of four meteors doubly observed on this notable night.

Sept. 30, H.	M.			Height at first. M.	Height at last. M.	Path. M.	Velocity per second. M.	Radiants.
8	20	...	2—4	... 66	... 59	... 45	... 30	... 106°+47°
8	42	...	2—3	... 79	... 52	... 34	... 16	... 4°+28°
9	5	...	> ♀	... 81	... 48	... 41	... 14	... 6°+27°
9	20	...	1—2	... 69	... 69	... 54	... —	... 119°+34°

Other observations of meteors on September 30th would be very acceptable for comparison.

THE FACE OF THE SKY FOR DECEMBER.

By W. SHACKLETON, F.R.A.S., A.R.C.S.

THE SUN.—On the 1st the Sun rises at 7.44 and sets at 3.54; on the 31st he rises at 8.8 and sets at 3.58. The equation of time on the 25th at noon is only 13 seconds, and for ordinary purposes is negligible. Winter commences on the 22nd, when the sun enters the sign of Capricorn at 10.54 p.m.; this is the shortest day, the Sun rising at 8.5 and setting at 3.51. Sunspots and faculae may usually be observed on the solar disc, though of late Spots have been rather small. The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given below:—

Date.	Axis inclined from N. point.	Centre of Disc N. or S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Dec. 2 ...	15° 59′E	0° 40′N	192° 10′
,, 7 ...	13° 57′E	0° 2′N	126° 16′
,, 12 ...	11° 49′E	0° 37′S	60° 23′
,, 17 ...	9° 33′E	1° 14′S	354° 31′
,, 22 ...	7° 12′E	1° 52′S	288° 39′
,, 27 ...	4° 49′E	2° 29′S	222° 47′
Jan. 1 ...	2° 22′E	3° 5′S	156° 56′

THE MOON:—

Date.	Phases.	H. M.
Dec 6 ...	○ Full Moon	2 52 a.m.
,, 12 ...	☾ Last Quarter	5 46 p.m.
,, 20 ...	● New Moon	3 40 p.m.
,, 28 ...	☽ First Quarter	6 48 p.m.
Dec. 7 ...	Perigee	1 0 a.m.
,, 22 ...	Apogee	2 6 a.m

OCCULTATIONS.—Particulars of the principal occultations visible in this country are given in the table below:—

Date.	Star's Name	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point. E.	Mean Time.	Angle from N. point. E.
			p.m.		p.m.	
Dec. 3	29 Arietis ...	6·1	8.10	102°	9.0	194°
,, 6	B.A.C. 1754 ..	5·7	6.42	37°	7.24	296°
,, 7	136 Tauri ...	4·6	a.m. 1.46	19°	a.m. 2.11	337°
,, 8	47 Geminorum...	5·6	5.23	96°	6.22	290°
,, 8	ω^1 Cancri ...	6·1	p.m. 9 31	65°	p.m. 10.24	305°
,, 8	ω^2 Cancri ...	6·2	9.54	127°	10.46	244°
,, 9	λ Cancri ...	5·9	a.m. 6.48	123°	a.m. 7.44	279°
,, 24	33 Capricorni ...	5·3	p.m. 5.25	22°	p.m. 6.21	280°

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
Dec. 1 ...	17 51	S 25° 52′
,, 11 ...	18 38	S 24° 47′
,, 21 ...	18 34	S 22° 12′
,, 31 ...	17 43	S 20° 14′

Mercury is an evening star in Sagittarius setting about 5 p.m. from the 10th to the 20th, but unfavourably placed for observation. The planet is at greatest easterly elongation from the Sun of 20° 58′ on the 7th, whilst on the 16th he is stationary, after which he describes a retrograde path, and is in inferior conjunction with the Sun on the 25th.

VENUS:—

Date.	Right Ascension.	Declination.
	h. m.	
Dec. 1 ...	13 23	S 6° 26′
,, 11 ...	14 4	S 9° 55′
,, 21 ...	14 47	S 13° 22′
,, 31 ...	15 33	S 16° 31′

Venus is a morning star first in Virgo, then in Libra; she rises in the E.S.E. at 3.15 a.m. on the 1st, and at 4.21 a.m. on the 31st. As seen in the telescope the planet appears gibbous, 0·6 of the disc being illuminated; the apparent diameter of the planet is 20″.

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
Dec. 1 ...	3 48	N 21° 31′
,, 11 ...	3 35	N 21° 10′
,, 21 ...	3 27	N 20° 58′
,, 31 ...	3 26	N 21° 0′

Mars is a very conspicuous object in the S.E. portion of the sky at sunset; he appears as a bright reddish star about 3° South of the Pleiades, where he is describing a short retrograde path; the planet is at the stationary point on the 29th.

On the 1st he is due South at 11.9 p.m., on the 15th at 9.57 p.m., and on the 31st at 8.49 p.m.; he remains above the horizon till the early hours of the morning.

The latitude of the planet's centre is −13°, hence the South Polar Cap is visible. The time of rotation is $24^h\ 37^m\ 22^s{\cdot}65$, which is equivalent to 14°·62 per hour, and the time of transit of the Zero Meridian of the planet is as follows:—

Date.	Transit of Zero Meridian.	Date.	Transit of Zero Meridian
	h. m.		h. m.
Dec. 2 ...	2 51 p.m.	Dec. 19	0 35 a.m.
,, 4 ...	4 4 ,,	,, 21 ...	1 49 ,,
,, 6 ...	5 16 ,,	,, 23 ...	3 3 ,,
,, 8 ...	6 29 ,,	,, 25 ...	4 17 ,,
,, 10 ..	7 42 ,,	,, 27 ...	5 32 ,,
,, 12 ...	8 55 ,,	,, 29 ..	6 46 ,,
,, 14 ..	10 8 ,,	,, 31 ...	8 1 ,,
,, 16 ...	11 21 ,,		

With the above data the longitude of the centre of Mars can easily be calculated for any moment. It may be noted that the zero meridian passes through the bay of the Sinus Sabaeus. The following well-known markings are visible at 9 p.m. on the dates mentioned below:—Aurorae Sinus on the 6th. Sinus Sabaeus on the 12th, Syrtis Major on the 19th and the Mare Cimmerium on the 28th. Most of the markings require at least a telescope of six inches aperture and good seeing to discern any detail, though dusky patches can be made out on the planet's disc with telescopes of smaller aperture. The Moon appears near Mars on the morning of the 5th, conjunction taking place at 3.55 a.m., Mars being 0° 50′ to the South.

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
Dec. 1 ...	15 44	S 18° 59′
,, 11 ...	15 53	S 19° 28′
,, 21 ...	16 2	S 19° 55′
,, 31 ...	16 10	S 20° 18′

Jupiter is a morning star, rising at 6.50 a.m. on the 1st and at 5.22 a.m. on the 31st; owing to his apparent proximity to the Sun, the planet is not observable till the end of the month, and for the same reason his satellites are inobservable. The planet appears in Scorpio and is in conjunction with β Scorpii on the 20th, the planet being about 16′ to the South of the star.

SATURN:—

Date.	Right Ascension.	Declination.
	h. m.	
Dec. 1 ...	2 53	N 13° 58′
,, 16 ...	2 50	13 44
,, 31 ...	2 47	N 13 37

Saturn is a very conspicuous object in the evening sky looking S.E.; he appears about 10° to S.W. of the Pleiades and Mars. He appears due south at 10.15 p.m. on the 1st, 9.12 p.m. on the 16th, and 8.11 p.m. on the 31st, that is, about four miuutes earlier each day.

On the meridian he appears about 52° above the horizon as the brightest star in that portion of the heavens, excepting Mars, but he may readily be distinguished from Mars by his lustreless appearance.

The planet may be seen in detail in quite small telescopes; even telescopes of only 2-in. aperture are sufficient to observe details on the disc as well as the Cassini division in the ring, using a magnification of 100, whilst the ring itself may be seen with a magnifying power of 50. The dark or crape ring requires at least a 4-in. telescope, but it is seen to better advantage in larger telescopes. The diameter of the ball is 18″, whilst the diameters of the outer major and minor axes of the ring are 45″ and 16″ respectively. The Southern surface of the ring is presented to us at an angle of 21° to our line of vision; thus the ring appears well open.

The Moon will appear near the planet on the evening of the 31st, Saturn being 4° to the South.

URANUS:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Dec. 1 ...	19 55 23	S 21° 20′ 55″
,, 31 ...	20 1 47	S 21° 2′ 40″

Uranus is approaching conjunction with the Sun, which takes place 20th January, and hence is practically unobservable, as he sets about 6.30 p.m. near the middle of the month.

NEPTUNE:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Dec. 1 ...	7 40 55	N 20° 50′ 8″
,, 31 ...	7 37 58	N 20° 57′ 11″

Neptune rises at 7 p.m. on the 1st, and at 5 p.m. on the 31st, whilst on these dates he is due south at 3 a.m. and 1 a.m.

He is becoming more favourably placed for observation in the evenings, as he is in opposition on January 13th.

The planet is situated in Gemini, where he is describing a short retrograde path about 7° due south of Pollux and about 5° E. by S. of δ Geminorum, but in small telescopes without setting circles it is difficult to identify from the numerous small stars in the same field of view. He may, however, be detected by his motion, if observations are made on several successive nights.

METEORS.—The principal shower of meteors during the month is the Geminids, December 10th to 12th; the radiant is near Castor, in R.A. VII^h 12^m, Dec. +33°. The meteors are short and quick, and difficult to record accurately.

Minima of Algol may be observed on the 14th at 11 p.m., the 17th at 8 p.m., and the 20th at 4.30 p.m. The period is 2^d 20^h 49^m, from which other minima be calculated.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—1 Pegasi 21^h 17·5^m, N. 19° 20′, mags. 4·5, 8·6; separation 36″·2.

πAndromedæ 0^h 31·5^m, N. 33° 11′, mags. 4·0, 8·0; separation 36″·3.

α Piscium 1^h 56·9^m, N. 2° 17′, mags. 3·7, 4·7; separation 3″·6.

ι Trianguli 2^h 6·6^m, N. 29° 50′, mags. 5, 6·4; separation 3″·5.

CLUSTERS.—(H VI. 33, 34.) The Perseus clusters visible to the naked eye and situated about midway between γ Persei and δ Cassiopeiæ. These magnificent clusters are described by Smyth as "affording together one of the most brilliant telescopic objects in the heavens."

(M 34.) A mass of small stars about the 8th magnitude; not very compact. The cluster is just perceptible to the naked eye about 5° North-West of Algol.

NOTICES.

ROYAL INSTITUTION.—A General Monthly Meeting of the Members of the Royal Institution was held on November 6th, the Duke of Northumberland, K.G., President, in the Chair. The Chairman reported the decease of the Right Hon. Earl Cathcart, D.L., J.P., a Manager, Professor G. L. Van der Mensbrugghe, Professor W. V. Spring and Professor L. J. Troost, Honorary Members of the Royal Institution, and resolutions of condolence with the families were passed. The Eighty-sixth Christmas Course of Juvenile Lectures, founded at the Royal Institution in 1826, by Michael Faraday, will be delivered this year by Dr. P. Chalmers Mitchell, D.Sc., LL.D., F.R.S., Secretary of the Zoölogical Society, his subject being "The Childhood of Animals." The Lectures will be delivered on the following dates, at 3 o'clock: Thursday, December 28th; December 30th, 1911; January 2nd, 4th, 6th, and 9th, 1912.

INTERNATIONAL CONGRESS OF ENTOMOLOGY. CORRECTED DATE.—The Second International Congress of Entomology will be held at Oxford, from August 5th to 10th, 1912, and not as previously announced. The President of the Congress is Professor E. B. Poulton, D.Sc., F.R.S. All communications and enquiries should be addressed to the General Secretary of the Executive Committee, Dr. Malcolm Burr, c/o Entomological Society of London, 11, Chandos Street, Cavendish Square, London, W.

XUM

CORRESPONDENCE.

THE FLIGHT OF THE ALBATROSS.

To the Editors of "KNOWLEDGE."

SIRS,—We often hear of the mystery of how the Albatross can fly without flapping its wings. I have often by the hour closely watched these birds on the wing, and seen that they make no movement save slight guiding and directing alterations of tail and wing. The head is moved about freely to look in all directions, and the bird will occasionally scratch itself with claw or beak, for they always swarm with vermin, but usually there is no flapping of the wings at all.

In these days of fast steamers, as there are few opportunities of watching their flight, may I record my evidence of how one of these birds will thus follow a ship for many days and nights together?

First, they only fly in their characteristic manner while the wind is blowing. As the wind drops they begin to flap; and as a calm comes on they soon tire of flying by flapping and settle on the sea like great ducks. Then when enough wind remains to move the ship they are usually left behind and not seen again. Why they so soon tire of flapping is because the humerus (arm-bone) is very long, while the pectoral muscles are comparatively small and supported by a small keel to the sternum.

Presumably they use the wind to help them to fly. But how?

All the while they are flying they are repeatedly rising high into the air, then swooping down close to the sea surface, and then up again. If there was no friction nor other loss of energy, the impetus of the swoop would enable the creature to rise to as high a spot as it came down from. Or if it could get from the wind a little impetus to replace the certain loss of energy the bird could continue to rise and fall as long as the wind blew. It does this.

When there is wind at sea there are also waves. As the wind slides up the back of a wave towards the crest it is directed upwards. The Albatross always swoops deep into the trough of the sea, where it is somewhat sheltered from the wind, and there, facing towards the on-coming wave, it begins to rise close to the front surface of the wave. When it crosses the crest the bird may be seen to get a distinct "lift" from the up-current of air.

To fly by this method across the wind, or in the direction of the wind, the Albatross has to make curious gyrations, so as to face the wind after each swoop. If this manoeuvre is prevented, as by the distraction of some tit-bit or a quarrel with a companion, the bird has to flap and fly like any other gull.

This mystery is as usual made by omitting a necessary detail of description; as also when we are told that often when placed on deck this sea-bird is sea-sick! If we were told that while it was being hauled on board the bird had gaped its beak wide open to get the hook out, and being dragged through the crests of several waves it had thus swallowed large quantities of sea water, then we should guess that it was sick from sea water, not from the motion of the ship.

How the Albatross can do without sleep for so long remains a mystery. It sometimes looks half asleep while it executes its monotonous movements.

T. ARCH. DUKES.

ROTATION OF VENUS.

To the Editors of "KNOWLEDGE."

SIRS,—The April Number of "KNOWLEDGE" contained a short article of mine on the above subject, in which I advanced some reasons for assuming that Venus still has a rotation period shorter than its year, even though this rotation might be too slow to be detected from observation. It is interesting to learn that since then M. Belopolsky has confirmed some of his previous spectroscopic work, giving the planet a period of 1·44 days. This result is in accord with theory, and corroborates to a great extent the early observations of Schroter and De Vico. On the other hand Mr. Slipher has obtained no indication of a rapid rotation from the spectrum of Venus, which agrees with the direct visual work of Schiaparelli and Lowell.

These conflicting observations of experienced astronomers are very unsatisfactory, and are the more extraordinary as each result has been confirmed by an independent method of research. We can only hope that ere long some decisive evidence may be obtained upon this, at present, baffling question.

B. G. HARRISON.

CLUSTERS AND NEBULAE.

To the Editors of "KNOWLEDGE."

SIRS,—Referring to my article "Clusters and Nebulae" in your September number, I have just received a letter from Dr. Fath, of the Mount Wilson Solar Observatory, Pasadena, California, together with a minute print of one of his Lick Spectrograms of the Andromeda Nebula. Notwithstanding its small scale there appear to be indications of lines corresponding to those in the solar spectrum, and he states there are other fainter lines (lost in the print).

I am accordingly sending you this note at his desire, so that it may be seen that his opinion (quoted on page 344, column 1) was not given without evidence. Dr. Fath also states in his letter "Dr. Lockyer and Mr. Frank McClean were here a few months ago, and saw some of the original negatives. I believe they will agree that these absorption lines are well marked in the originals."

F. W. HENKEL.

THE VELOCITY OF LIGHT.

To the Editors of "KNOWLEDOE."

SIRS,—Surely your correspondent, G. R. Gibbs, is trying to hoax your readers with his suggestion that light has its velocity reduced by the earth's atmosphere to some twenty miles a second because he can see a flash of lightning. Considering that he admits that the observations for computing the velocity of light actually showed a velocity of one hundred and eighty-six thousand miles a second near the earth's surface, it is difficult to see on what principle of logic he yet considers that twenty miles is the correct figure. Does he really imagine that a brilliant spark will become invisible if it takes less than one-tenth of a second to accomplish its path? Considering that the spark of an electric machine is visible when one-tenth of an inch long, are we to infer that such sparks only travel one inch in a second?

CHARLES E. BENHAM.

To the Editors of "KNOWLEDGE."

SIRS.—Theosophists state that the Earth has a motion which has not yet been discovered by Astronomers.

This motion consists of the rotation of the Earth's axis about its centre thereby causing the Earth to "turn turtle" as the saying is, in other words that in time the Southern Hemisphere will face the Pole star in a similar manner that the Northern Hemisphere does at present.

If this statement is correct it would fully account for the various large changes in temperature which appear to have taken place in the different parts of the Earth.

Does not the difference in the inclinations of the axes of the planets to the planes of their orbits point to the possibility of all the planets being subject to this motion?

F. G. STOPFORD (Admiral).

XUM

THE COAL RESOURCES OF THE UNITED KINGDOM.

To the Editors of "KNOWLEDGE."

SIRS,—Attention has again been attracted to the contents of our natural coal store. Experts have pointed out that we are rapidly exhausting the coal resources of our country, and they estimate the life of our coalfields to be less than two hundred years. Half a century ago, experts gave a similar estimate, and we have during the last fifty years withdrawn millions of tons from the natural store.

It is of interest, and as well assuring, to note that whilst the Royal Commission of 1871 estimated the "available coal" at 90,207,285,000 tons, the final report of the 1905 Commission gave the quantity of available coal as 100,914,668,167 tons. Thus the figures of the last Commission exceeded those of 1871 by 10,707,383,167 tons, and it must be considered that during the period 1871-1905, no less than 5,694,928,507 tons had been brought to bank.

Since the last Commission sat, there have been considerable additional coal areas proved in Lincolnshire and in the South of England. A reasonable survey of the coal "in store" within the United Kingdom gives ample assurance that our coal supplies are safe for the next five hundred years.

National economy requires a periodical stocktaking of available coal, and demands that the coal drawn from the natural store shall be economically utilized.

Every ton of coal mined reduces the assets of the nation, and it is a national duty to prevent avoidable waste, in (*a*) winning coal from its natural bed, and (*b*) in the conversion of the potential energy of the coal into useful work.

Few people realize the amount of power which is stored in coal. One teaspoonful of British coal contains sufficient energy to lift two modern locomotives to a height of one foot. A piece of coal the size of a man's fist has power enough to throw a weight of thirty pounds to a height of one-and-a-quarter miles. In our houses we use coal by the shovelful; but if the heat stored in the coal was efficiently utilized the coal-spoon would displace the shovel. To boil a gallon of water we require a large fire; yet the heat produced by one pound of coal is sufficient to raise to boiling point one hundred pounds or ten gallons of water.

Industrially we only utilize one-tenth of the power stored in coal; the balance (nine-tenths) is used up or wasted in the process of securing the one-tenth.

A National Conservancy is needed to protect the national store of solid fuel, and to obtain a better efficiency in the every-day use of coal. The industrial and maritime power and progress of our nation is founded on the enormous stores of first-grade coal and the large annual production.

Within the United Kingdom no less than two hundred millions of tons of coal are consumed annually, and the yearly export is well over sixty millions of tons. The important bearing of these figures on our national industries is quite obvious.

It is a national duty to win every ton of coal from the natural store in the most economical manner possible, and to obtain from the coal produced the highest possible value. These points are worth the attention of the nation's economists, and provide a wide field for profitable scientific investigation.

MYLES BROWN.

QUERIES AND ANSWERS.

Readers are invited to send in Questions and to answer the Queries which are printed here.

QUESTIONS.

55. THE NEW ASTRONOMY.—I should be very grateful for any information as to the variability of double stars, and especially I should like to know of binaries that are doubly variable. If spectroscopists would look for lines of planetary nebulae about variable doubles, about the Cepheids, and about variables whose light curve ascends more quickly than it descends, they might supply useful information. I should also be glad to know if another variable could be found in the neighbourhood of variables with that kind of light curve when one exists alone. It would also be valuable to the theory to find if nebulosity at minimum exists in the case of any of the Cepheids. On page 80 in "The Birth of Worlds and Systems" (Harper's Library of Living Thought), I have given a table of variables that I picked out from Gore's list; nebulosity should be looked for between the constituents of each pair, or perhaps surrounding them if close. The lines of planetary nebulae should also be looked for about them. The old measures should be compared with the new ones, to see if the stars are still separating, or if they are in long ellipses. Their exact angle and distance should now be determined to make future comparisons. I should also be pleased if the position where novae have appeared were examined for nebulosity, for faint fluctuations of light, and for the lines of planetary nebulae. The Owl and Dumb-bell nebulae seem to me to be planetary nebulae. I should be glad to know if they show the characteristic lines; the singular bilateral symmetry suggests that each is a third body struck from grazing suns. In the case of the Owl the eyes may be the two original moderately rare bodies; it would be interesting to know if any changes of form or structure in these or other planetary nebulae have been observed, and it would also be desirable to know the several chemical elements of the sphere-in-sphere constituents of these nebulae.

Mr. McCarthy, in his encouraging letter, speaks of the exact comparison he finds to exist between the deduced properties of the third body and those observed in Nova Persei. Mr. Raffety is a careful spectroscopic student; I should like to know if he has compared the two, and to have his opinion as to temporary and variable stars being the result of partial impact and the third body.

A. W. BICKERTON.

56. WATER SNAILS (*PLANORBIS CORNEUS*).—Would one of your readers describe the parasite of the Water Snails (*Planorbis Corneus*, and so on). It appears to eat into the shell and ultimately causes the death of the host.

J. M.

57. SOLAR SPECTRUM.—Why in photographs of the solar spectrum from diffused daylight (a bright sky) the lines are never sharp, as in the case from direct sunlight, though the slit has the same width?

C. A. S.

58. In a train of prisms for great dispersion, is there interference of light where the two beams of light cross? If not, why? And if there is, why is there no interference effect in the spectrum?

C. A. S.

ANSWERS.

51. THE GEOLOGY OF SOUTH DORSET.—Information asked can easily be obtained by turning up "Kelly's Directory of Hampshire, Wiltshire, Dorsetshire and the Channel Isles, 1907," where an outline of the Geology of Dorsetshire is ably described by W. Jerome Harrison, F.G.S., in which he not only gives a full account of the Strata, Minerals, and Fossils, but also of the names and writers of the numerous books treating on the Geology of the district. There is also a splendid collection of fossils in the Museum at Dorchester. The publications of the Government geological survey maps and reports, Map Sheet 16, Poole, Wareham and Swanage, take up the latest details; these can be obtained from Mr. Henry Ling, Bookseller, Dorchester, Dorsetshire.

A. M. W.

XUM

THE FACE OF THE SKY FOR JANUARY, 1912.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

THE following table gives the Right Ascension and Declination of the Sun, Moon and Planets at intervals of 5 days, at Greenwich noon.

The following table gives for the Sun, Mars and Jupiter:—P the Position Angle of the Sun's or Planet's North Pole, measured from the North Point of the disc towards the East,

THE SUN is nearest to the earth on Jan. 3, distance 91¼ million miles; it is commencing its northward march, slowly at first, but with increasing speed. At Greenwich it rises at 8.8 on Jan. 1, sets at 3.58; it rises at 7.44 on Jan. 31, sets at 4.43. Its semi-diameter diminishes during the month from 16′ 18″ to 16′ 15″. The minimum of sunspot activity is

Date.	Sun.		Moon.		Mercury.		Venus.		Mars.		Ceres.		Jupiter.		Saturn.		Neptune.	
	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.
	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Jan. 1 ..	18 42·3	S.23·1	3 35·1	N.21·8	17 39·8	S.20·2	15 37·9	S.16·8	3 25·6	N.21·0	8 21·5	N.28·7	16 11·3	S.20·3	2 47·1	N.13·6	7 37·9	N.21·0
,, 6 ..	19 4·4	22·6	9 5·6	N.21·7	17 35·8	20·5	16 1·8	18·2	3 27·0	21·1	8 17·5	29·3	16 15·4	20·5	2 46·7	13·6	7 37·3	21·0
,, 11 ..	19 26·2	22·0	13 22·1	S. 8·2	17 46·0	21·2	16 26·2	19·4	3 29·5	21·3	8 13·1	29·9	16 19·5	20·7	2 46·4	13·6	7 36·7	21·0
,, 16 ..	19 47·8	21·1	17 27·9	27·4	18 5·2	22·1	16 51·1	20·4	3 33·2	21·5	8 8·2	30·5	16 23·4	20·8	2 46·3	13·6	7 36·1	21·0
,, 21 ..	20 9·2	20·1	21 45·1	S.18·3	18 29·9	22·7	17 16·4	21·2	3 37·9	21·8	8 3·2	31·1	16 27·2	21·0	2 46·4	13·7	7 35·5	21·1
,, 26 ..	20 30·2	19·0	1 31·2	N. 9·5	18 58·0	22·9	17 42·1	21·7	3 43·6	22·1	7 58·2	31·5	16 30·9	21·1	2 46·6	13·7	7 34·9	21·1
,, 31 ..	20 50·9	S.17·7	6 21·9	N.28·1	19 28·1	S.22·7	18 8·1	S.22·0	3 50·0	N.22·4	7 53·4	N.31·9	16 34·4	S.21·2	2 47·1	N.13·8	7 34·3	N.21·1

TABLE 1.

B the Heliographical or Planetographical latitude of the centre of the disc, and L the Heliographical or Planetographical longitude of the centre of the disc, which in the case of the Sun or Jupiter is reckoned from an arbitrarily chosen zero meridian, in the case of Mars from the marking Fastigium Aryn (formerly called Dawes Forked Bay). That of Jupiter, system II, originally coincided with the great Red Spot. Two values are given for Jupiter: I corresponds to the equator, II to temperate zones. T the time of transit of the zero meridian is also given for each of the given dates. Here and elsewhere in these pages the time used is Greenwich Civil Time, day beginning at midnight, and the letters *m* (morning), *e* (evening) are used as abbreviations for a.m. and p.m. The quantities P, B, are also given for Saturn, and serve to indicate the position of the minor axis of the ring, and the amount of its opening. The additional quantities Q, q, given for Mars are the Position Angle (from North Point towards East) and the amount, in seconds of arc, of the greatest defect of illumination.

expected in 1912 or 1913, but cannot as yet be predicted with mathematical accuracy.

THE MOON is Full, Jan. 4, 1h 30m *e.*; L.Q., Jan. 11, 7h 43m *m.*, New, Jan. 19, 11h 10m *m.*; F.Q., Jan. 27, 8h 51m *m.*; Perigee; Jan. 4, 2h *e.*, distance 221,400 miles (an unusually close approach); Apogee, Jan. 18, 2h *m.*, distance 264,600 miles.

The following gives the dates of the Moon's maximum librations: Dec. 29, 8° E.; Jan. 5, 6° S.; Jan. 10, 8° W.; Jan. 19, 7° N.; Jan. 26, 7° E.; Feb. 1, 7° S. The letters E. W. indicate that the region brought into view is on the East (Mare Humorum side), or West (Mare Crisium side) respectively. The letters N. S. indicate that the regions brought into view are at the Moon's N. or S. Poles. Observers will do well to watch their libration opportunities to improve our knowledge of the regions near the limb.

The occultations visible at Greenwich are given on page 475.

MERCURY is a morning star. It reaches W. elongation

Date.	Sun.			Mars.						Jupiter.						Saturn.	
	P	B	L	P	B	L	Q	q	T	P	B	L_I	L_{II}	T_I	T_{II}	P	B
	°	°	°	°	°	°	°	″	h m	°	°	°	°	h m	h m	°	°
Jan. 1	2·4	S.3·1	156·9	323·2	S.14·8	49·0	77·8	·73	8 39 m	10·6	S.2·9	26·5	86·5	9 7 e	7 32 e	359·5	S.20·5
,, 6	359·9	3·6	91·1	323·2	14·7	3·0	77·6	·80	11 48 m	10·1	2·9	95·2	117·1	7 14 e	6 42 e	359·5	20·5
,, 11	357·5	4·2	25·2	323·3	14·5	316·8	77·5	·86	2 57 e	9·7	2·9	164·1	147·7	5 21 e	5 51 e	359·5	20·5
,, 16	355·1	4·7	319·4	323·4	14·1	270·3	77·6	·90	6 8 e	9·3	2·9	232·9	178·5	3 28 e	5 0 e	359·5	20·5
,, 21	352·8	5·2	253·6	323·6	13·7	223·6	77·7	·91	9 20 e	8·9	2·9	301·2	209·2	11 26 e	4 9 e	359·5	20·5
,, 26	350·6	5·6	187·7	323·8	13·2	176·7	78·0	·92	—	8·6	2·9	10·8	240·0	9 31 e	3 18 e	359·5	20·6
,, 31	348·4	S.6·0	121·9	324·1	S.12·6	129·6	78·4	·92	3 8 m	8·2	S.2·9	79·8	270·9	7 39 e	2 27 e	359·5	S.20·8

TABLE 2.

The values of T_I T_{II} for Jupiter on intermediate days may be found by applying multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{3}{4}^m$ respectively.

It should be mentioned that L is reckoned in the opposite direction on the Sun from that used on Mars and Jupiter. This difference is unfortunate, but it has become established and cannot now be altered.

The two systems may be best explained thus: in that used for the Sun the longitudes of Bombay and New York from Greenwich would be 73°, 286° respectively; in that used for Mars and Jupiter the same two longitudes would be Bombay 287°, New York 74°.

(24° from Sun), Jan. 15. It is 6° N. of Moon, Jan. 17, 6h *m.* Its diameter diminishes during month from 9″ to 5″; the illuminated part of disc increases from $\frac{1}{6}$ to $\frac{5}{6}$.

VENUS is a morning star, pretty well placed for observation. It is 6° N. of Moon, Jan. 15, 5h *e.* Its diameter diminishes from 18″ to 15″; the illuminated part of disc increases from $\frac{2}{3}$ to $\frac{3}{4}$.

MARS has passed opposition, but is still well placed for observation. The vernal equinox of the Northern Hemisphere

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occurs on Jan. 14. His diameter diminishes from 13½″ to 10″. Veiling of surface details by mist or cloud in the Martian atmosphere seems to have occurred in several regions of the planet in October, according to MM. Antoniadi, Jarry-Desloges, and others.

CERES, the largest of the asteroids, is in a very favourable opposition in January, being in high north declination, and also near perihelion. Its diameter is 430 miles, just $\frac{1}{5}$ of the Moon's, and it will be of the 7th magnitude, and thus easily visible in the smallest telescope or binocular; a map of surrounding stars is given, which should make it easy to pick the object up and follow its motion from day to day. The brightest stars in the map are of mag. 5½, the faintest of mag. 9½. Faint stars are only shown when fairly near the planet's track.

JUPITER is a morning star, and just beginning to become observable after conjunction with the Sun. Its Equatorial Diameter increases from 32″ to 34″; the Polar is 2″ less. The defect of illumination on the West limb is $\frac{1}{5}$″. The configurations of the satellites as seen with an inverting telescope at 6^h *m* are:—

Day.	West.	East.	Day.	West.	East.
Jan. 1	$\frac{2}{4}$ ○	13	Jan. 17	34 ○	12
,, 2	41 ⊙	2	,, 18	$\frac{3}{4}$ 12 ○	
,, 3	43 ○	12	,, 19	432 ○	1
,, 4	$43\frac{1}{2}$ ○		,, 20	41 ○	32
,, 5	$4\frac{8}{2}$ ○	1	,, 21	4 ○	123
,, 6	41 ○	32	,, 22	421 ○	3
,, 7	4 ○	$\frac{1}{2}$ 3	,, 23	42 ○	13
,, 8	2^4 ○	3 1●	,, 24	43 ○	2 1●
,, 9	1 ○	34 2●	,, 25	31 ⊙	4
,, 10	3 ○	124	,, 26	32 ○	14
,, 11	312 ○	4	,, 27	13 ○	24
,, 12	32 ○	14	,, 28	○	1234
,, 13	1 ○	324	,, 29	21 ○	34
,, 14	○	1234	,, 30	2 ○	134
,, 15	21 ○	$\frac{3}{4}$	,, 31	3 ○	24 1●
,, 16	2 ⊙	$\frac{3}{4}$			

The following phenomena are visible at Greenwich:— $1^d\ 5^h\ 40^m$ *m*, I. Oc. R.; $2^d\ 6^h\ 14^m$ *m*, III. Tr. E.; $7^d\ 7^h\ 24^m$ *m*, I. Sh. I.; $8^d\ 7^h\ 40^m$ *m*, I. Oc. R.; $9^d\ 5^h\ 23^m$ *m*, III. Sh. I.; $7^h\ 1^m$ *m*, II. Oc. R.; $7^h\ 12^m$ *m*, III. Sh. E.; $15^d\ 6^h\ 34^m\ 32^s$ *m*, I. Ec. D.; $16^d\ 4^h\ 40^m$ *m*, I. Tr. I.; $5^h\ 21^m\ 19^s$ *m*, II. Ec. D.; $5^h\ 58^m$ *m*, I. Sh. E.; $6^h\ 53^m$ *m*, I. Tr. E.; $18^d\ 4^h\ 37^m$ *m* II., Tr. E.; $20^d\ 5^h\ 14^m$ *m*, III. Oc. R.; $23^d\ 5^h\ 38^m$ *m*, I. Sh. I.; $6^h\ 38^m$ I. Tr. I.; $7^h\ 51^m$ *m*, I. Sh. E.; $24^d\ 6^h\ 8^m$ *m*, I. Oc. R.; $25^d\ 4^h\ 44^m$ *m*, II. Tr. I.; $5^h\ 18^m$ *m*, II. Sh. E.; $7^h\ 23^m$ *m*, II. Tr. E.; $27^d\ 5^h\ 8^m\ 5^s$ *m*, III. Ec. R.; $7^h\ 35^m$ *m*, III. Oc. D.; $30^d\ 7^h\ 31^m$ *m*, I. Sh. I.; $31^d\ 4^h\ 50^m\ 17^s$ *m*, I. Ec. D. The eclipses take place high left of the disc in an inverting telescope, considering the direction of the belts as horizontal.

SATURN is still well placed for observation. Its equatorial diameter is 19″, major axis of ring 44″, minor axis 15″. The shadow of the ball on the ring is visible on the East side. The satellites except the outer ones, Iapetus and Phoebe, are in almost the same plane as the ring, so their apparent orbits are widely open ellipses. The times of some Eastern Elongations are given; intermediate ones are found by applying multiples of $1^d\ 21^h$ for Tethys, $2^d\ 18^h$ for Dione, $4^d\ 12\frac{1}{2}^h$ for Rhea.

Tethys, $2^d\ 6^h\ e$; $8^d\ 10^h\ m$; $14^d\ 2^h\ m$; $19^d\ 6^h\ e$; $25^d\ 10^h\ m$; $31^d\ 2^h\ m$. Dione $2^d\ 3^h\ e$; $8^d\ 2^h\ m$; $13^d\ 2^h\ e$; $19^d\ 1^h\ m$; 24^d *noon*; $29^d\ 11^h\ e$. Rhea $5^d\ 10^h\ m$; $14^d\ 11^h\ m$; 23^d *noon*; Feb. 1^d *noon*. For Titan and Iapetus, E.W. stand for E. and W. elongations, I.S. for inferior and superior conjunctions. Titan $5^d\ 6^h\ m$ W, $9^d\ 4^h\ m$ S, $13^d\ 8^h\ m$ E, $17^d\ 9^h\ m$ I., $21^d\ 5^h\ m$ W, $25^d\ 3^h\ m$ S, $29^d\ 7^h\ m$ E. Iapetus, Jan. $16^d\ 9^h\ e$ I, Feb. $5^d\ 8^h\ m$ W. This satellite is much easier to see W. than E. of the planet; it is presumed to rotate in the same time as its revolution.

URANUS is invisible, being in conjunction with the Sun on January 20th.

NEPTUNE is very favourably placed, being in opposition on January 13th. It is of the 8th magnitude, 2⅓″ in diameter. A map is given of the stars near its path. Their magnitude ranges from 6½ to 9½. With its aid a powerful binocular or a 1½-in. telescope should find the planet. In December, it is $7\frac{1}{3}^\circ$ south of Pollux. Its satellite, Triton, is too faint to justify the inclusion of an ephemeris here.

COMETS.—The numerous comets visible in England in the autumn have now passed to the south, and become much fainter. Ephemerides are given for the use of southern observers; that of Brooks's comet is due to Dr. Smart.

It is hoped that Quenisset's Comet will be observed as long as possible in the Southern Hemisphere, as its orbit resembles that of 1790 III, and its identity appears possible.

BROOKS' COMET.

Date.	R.A. h. m. s.	S. Dec.	Log. r.	Log. Δ
Jan. 3	14 41 0	44° 13′	0·1738	0·2588
,, 7	14 47 8	45 33	0·1923	0·2660
,, 11	14 52 56	46 49	0·2099	0·2724
,, 15	14 58 12	48 1	0·2266	0·2781
,, 19	15 3 4	49 12	0·2424	0·2833
,, 23	15 7 12	50 19	0·2576	0·2878
,, 27	15 10 44	51 24	0·2722	0·2918
,, 31	15 13 44	52 27	0·2860	0·2953
Feb. 4	15 16 0	53 28	0·2993	0·2985
,, 8	15 17 40	54 27	0·3121	0·3011
,, 12	15 18 24	55 25	0·3245	0·3037
,, 16	15 18 24	56 19	0·3363	0·3062
,, 20	15 17 24	57 11	0·3478	0·3083
,, 24	15 15 32	58 1	0·3588	0·3102
,, 28	15 12 40	58 48	0·3695	0·3115

QUENISSET'S COMET.

Date.	R.A. h. m. s.	S. Dec.	Log. r.	Log. Δ
Dec. 31	15 49 37	29° 18′	0·0806	0·2567
Jan. 8	15 49 8	34 37	0·1171	0·2496
,, 16	15 47 7	40 11	0·1516	0·2406
,, 24	15 42 28	45 59	0·1838	0·2312
Feb. 1	15 33 35	52 1	0·2141	0·2226
,, 9	15 17 52	58 8	0·2421	0·2156
,, 17	14 50 1	64 5	0·2684	0·2124
,, 25	14 2 9	69 16	0·2929	0·2139

Borrelly's Periodic Comet will probably be an easy telescopic object in December and January in both hemispheres. The following ephemeris is by Dr. Smart, from M. Fayet's elements, taking 1911, December 18·01 Greenwich Mean Time as the date of perihelion.

(*Continued on page 476.*)

Date.	Star's Name.	Magnitudes.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. Pt. E.	Mean Time.	Angle from N. Pt. E.
			h m		h m	
Jan. 1 ...	32 Tauri	5·8	5.14 e	67°	6.17 e	243°
,, 1 ...	BAC 1238	6·5	7.51 e	354	8.12 e	319
,, 2 ...	62 Tauri	6·1	5 39 m	35	—	—
,, 2 ...	BD + 26° 796	6 8	10.16 e	77	—	—
,, 3 ...	BAC 2023	6 7	9. 8 e	157	—	—
,, 4 ...	BD + 27° 1164	6·9	4.40 m	90	—	—
,, 4 ..	BD + 27° 1194	7·7	6.32 m	83	—	—
,, 4 ...	BAC 2383	6·5	5. 0 e	43	5.35 e	315
,, 5 ...	c Geminorum	5·5	4.10 m	90	5. 6 m	304
,, 8 ...	l Leonis	5·3	6.22 m	160	7.12 m	267
,, 10 ...	η Virginis	4 0	0.31 m	182	1. 2 m	241
,, 16 ..	43 Ophiuchi	5·4	—	—	7.12 m	248
,, 25 ...	73 Piscium	6·2	8 45 e	56	9.47 e	247
,, 26 ...	BAC 542	7·0	5.21 e	31	—	—
,, 26 ...	54 Ceti	6 0	7.44 e	120	—	—
,, 27 ...	BAC 609	6·0	0.25 m	60	—	—
,, 27 ...	π Arietis	5·2	11.45 e	87	0.39 m*	238
,, 29 ...	BAC 1189	5·9	1.47 m	114	2.30 m	226
,, 29 ...	Mars	—	2.34 m	74	3.24 m	266
,, 29 ...	BD + 24° 674	6·8	8.16 e	108	—	—
,, 30 ..	BAC 1754	5 7	4.43 e	106	5.38 e	228
,, 30 ...	BD + 27° 880	7·0	10.33 e	61	—	—
,, 31 ...	136 Tauri	4·6	0.20 m	45	1. 2 m	321
,, 31 ..	BD + 27° 943...	7·0	2.52 m	98	—	—

TABLE 3. Occultations of stars by the Moon visible at Greenwich.

The asterisk indicates the day following that given in the date column. 0^h is used instead of 12^h. The occultation of Mars is not very favourable for observation, the Moon setting as the planet re-appears.

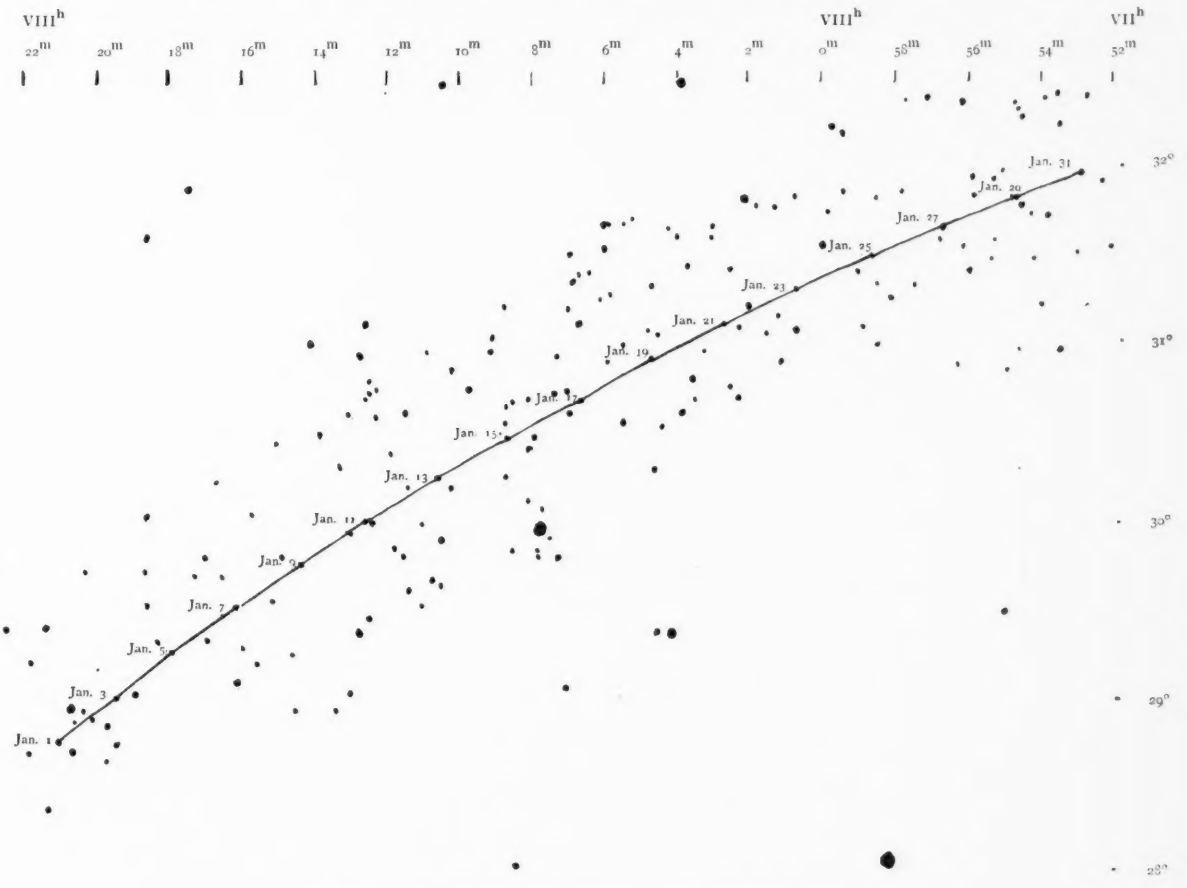

FIGURE 1. Stars near the path of Ceres, January, 1912.

BORRELLY'S COMET.

Date.	R. A.	Dec.	Log. r	Log. Δ
	h. m. s.			
Dec. 5 ...	2 56 24	S. 8° 38′	0·1492	9·7065
,, 13 ...	2 48 0	N. 0 8	0·1472	9·7120
,, 21 ...	2 43 16	8 55	0·1471	9·7328
,, 29 ...	2 42 32	17 3	0·1488	9·7653
Jan. 6 ...	2 45 52	24 12	0·1523	9·8052
,, 14 ...	2 52 44	30 17	0·1574	9·8491
,, 22 ...	3 3 20	35 15	0·1641	9·8931
,, 30 ...	3 17 28	N. 39 37	0·1720	9·9376

METEOR SHOWERS.—The following list of radiants for January is due to Mr. W. F. Denning.

Date.	Radiant.		Notes.
	R.A.	Dec.	
Jan. 2-3 ..	230°	N 53°	Brilliant shower, swift, long-paths.
,, 3 ...	156	N 41	Swift.
,, 11-25...	220	N 13	Swift, streaks.
,, 17 ...	295	N 53	Slow, bright.
,, 17-23...	159	N 27	Swift.
,, 25 ...	131	N 32	Swift.
,, 29 ...	213	N 52	Very swift.

VARIABLE STARS.—The following list gives every third minimum of Algol. Its magnitude ranges from 2·3 to 3·5. Period $2^d\ 20^h\ 49^m$. Jan. $6^d\ 9^h e.$, $15^d\ 11^h m.$, $24^d\ 2^h m.$, Feb. $1^d\ 4^h e.$

β Lyrae ranges from 3·4 to 4·5.

Max.	Principal Min.	Max.	Secondary Min.
Jan. $3^d\ 9^h m.$	$6^d\ 1^h e$	$9^d\ 3^h e.$	$12^d\ 12^h e.$
,, 16 7 *m*	19 11 *m.*	22 1 *e.*	25 10 *e.*
,, 29 5 *m.*			

DOUBLE STARS.—The period over which any double star can be observed is nearly always several months, and in some cases the whole year, But in order to make a distribution into months, I am adopting the principle of taking those which cross the meridian between 9^h and 11^h p.m. on the 20th of each month, *i.e.*, in January the limits of Right Ascension are 5^h to 7^h, in February 7^h to 9^h, and so on. Merely a brief selection of double stars, clusters and nebulae within these limits can be given.

The angle is measured from North towards East.

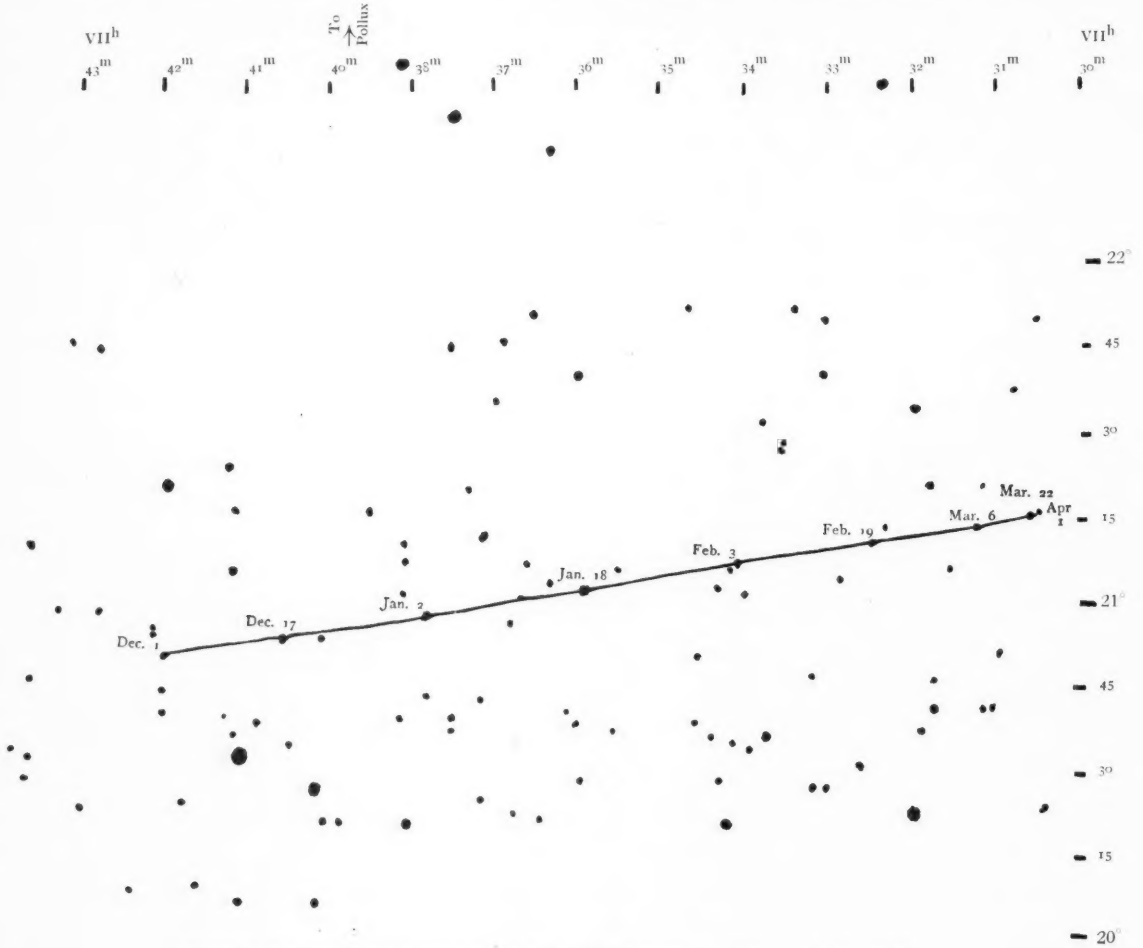

FIGURE 2. Stars near the path of Neptune, December, 1911, to April, 1912.

Star.	Right Ascension.	Declination.	Magnitudes.	Angle.	Distance.	Colours.
	h. m. s.					
ρ Orionis	5 8 40	2° 46′N	5,8	63°	7″	Yellow, blue.
ι Leporis	5 8 10	11 58 S	4,10	337	12	Bluish-white.
κ Leporis	5 9 10	13 3 S	5,8	358	3	Yellow, blue.
Rigel	5 10 17	8 18 S	1,8	202	10	Yellow, blue.
The companion is an exceedingly close double.						
118 Tauri	5 23 44	25° 4′N	6,7	202°	5″	White, blue.
λ Orionis	5 30 12	9 52 N	4,6	43	5	Yellow, purple.
θ^1 Orionis	5 30 55	5 27 S	The Trapezium in the Great Nebula.			
σ^2 Orionis	5 34 30	2 39 S	A quadruple star, the principal being an exceedingly close pair, with more distant companions of 6 mag., 7 mag., 10 mag.			
ζ Orionis	5 36 10	2 0 S	2,5	156°	2″	Yellow, blue.
4 Lyncis	6 14 0	59 25 N	6,8	103	1	White.
8 Monocerotis	6 19 2	4 30 N	4,7	24	13	Golden, lilac.
11 Monocerotis	6 24 30	6 58 S	5,5,6	132 106	7 3	Triple star.
12 Lyncis	6 38 24	59 31 N	5,6,7	116 306	1 8	Triple star.
Lal. F. 967	6 40 30	55 51 N	6,6	258	5	Yellow.
14 Lyncis	6 45 0	59 36 N	6,7	75	½	Orange, blue.
38 Geminorum	6 49 36	13 18 N	5,8	160	6	Yellow, blue.
μ Canis Majoris	6 52 3	13 56 S	5,8	338	3	Orange, red.
Piazzi VI 301	6 58 35	52 53 N	6,7	155	3	White.

CLUSTERS AND NEBULAE.

	R.A.	Dec.	
M 38	5h 22m	35° 49′N.	Cruciform cluster.
M 1	5 28	21 57 N.	The Crab Nebula; 1° N.W. of ζ Tauri.
M 42	5 30	5 27 S.	Great Nebula in Orion.
M 37	5 45	32 32 N.	Even in smaller instruments extremely beautiful (Webb).
M 35	6 2	24 21 N.	Very rich field.
H VII. 2	6 26	4 56 N.	Fine cluster, visible to naked eye.
M 41	6 43	20 38 S.	Visible to naked eye, 4° S. of Sirius.

EDITORIAL NOTE.

In accordance with the wishes of many of our readers Mr. Shackleton has, for the last few months, kindly made his notes on "The Face of the Sky" deal with the first week or so of the month following the date of issue of the Magazine, so that any delay in the receipt of the latter might not affect the usefulness of the column.

With this number, on account of the increasing pressure of other duties, Mr. Shackleton has given up the work which he has so well carried on for many years, and Dr. Crommelin, who has been so good as to undertake the duty, will prepare his notes a month ahead, so that "The Face of the Sky for January" is printed here. Our readers abroad will thus be in the same position as those at home.

NOTICES.

TRANSMISSION OF DISEASE BY MEANS OF BOOKS.—The undersigned is preparing a paper upon "Books as a Source of Disease," to be read before the next "International Congress of Hygiene," and in order to obtain data, respectfully requests the readers of this note to send him an account of any cases the source of which have been traced to books or papers, or where the evidence seemed to make books or papers the offender. He would also further request information where illness or even death has been caused by the poisons used in book-making.

All the information possible is wanted to present as complete a paper as possible. As in the case of insects which we now know to be "carriers of disease," it is first necessary to collect scattered evidence in order to show that there is real danger in books; and this will compel better care to be taken of libraries and books, and improve the health of mankind.—Wm. R. Reinick, 1709, Wallace Street, Philadelphia, Pa.

BOTANY IN THE "ENCYCLOPAEDIA BRITANNICA."—A careful perusal of the botanical articles in the eleventh edition of the "Encyclopaedia Britannica" shows that the revision of this section of the great work has been entrusted to reliable and experienced hands. The result is that, with a certain amount of addition in some directions and wholesale excision in others, this collection of articles would form an exceedingly good basis for a modern text book of Botany—certainly a much better one than any English work so far produced. Here and there the antiquity of the illustration blocks reminds one irresistibly of the fount whence the authors of "Wisdom While You Wait" drew so largely in writing their amusing skit, and it seems a pity that important articles on those departments of Botany in which so much recent literature is available have not been illustrated more adequately by new figures from that literature.

Most of the articles dealing with the great divisions of the vegetable kingdom—*e.g.* Algae, Fungi, Bryophyta, Pteridophyta, Gymnosperms—are models of lucidity, though in some cases interesting points have been omitted owing to the doubtless unavoidably small limits of space allotted to the compilers. In some cases this limitation has not permitted of the inclusion of speculative or controversial matter or of discussions regarding the relationships of the various groups. We get the facts, but very little of the "salt of morphological ideas," to use an expressive phrase of the late Sir Michael Foster's. However, there is in most cases a well-selected bibliography at the end of each of the longer articles, whence the reader may find guidance to the literature of the subject dealt with.

It is difficult to imagine what general principles, if any, underlie the selection of the biographies given in the list of botanical articles. Some of the naturalists whose lives are summarised can hardly be said to bulk largely in the history of Botany or to have advanced the science to such an extent as did many workers whose names are missing from the list. Among the omissions, one may mention such names as those of the two Gärtners (K. F. and J.), Hedwig, Ingenhouss, the Schimpers, Spruce and Unger.

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NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

WIRELESS TELEGRAPHY FOR TIME SIGNALS.—*L'Astronomie* for August gives an interesting account of the manner in which the Time Signals of the Paris Observatory are distributed by wireless telegraphy.

The standard clocks are kept in the "Catacombs," ninety feet under ground, where there is a practically constant temperature of 11°·8 C, the variations in several years being under 0°·02. The sidereal and solar clocks can be compared at a distance, their beats being rendered audible by microphones.

Wireless telegraphy was first used for distributing time signals on 23rd May, 1910. It is probably only a question of time before these or similar signals are available to ships in any part of the world, which will completely solve the problem of longitude at sea, with an accuracy formerly undreamt of. This and the gyro-compass are two revolutionary improvements in navigational methods during the last fifteen months.

The mean solar clock is put right, as at Greenwich, by an electro-magnet that can either aid or oppose the action of gravity on the pendulum. Several warning signals are sent by hand in a pre-arranged manner to give notice of the actual signal, which is sent automatically by the clock, and goes through a relay to the Eiffel Tower, whence it proceeds by wireless telegraphy. A note in the *Observatory* recently stated that a clockmaker at Canterbury regulates his clocks by the Paris signals, which were recently changed to accord with Greenwich Time. Germany has also a system of signals despatched from Norddeich, and Rio de Janeiro is about to follow suit. The French propose to use the method for the accurate determination of the difference in longitude between Paris, Bizerta (Tunis), Athens and possibly Lake Tchad.

MR. BARTRUM'S THIRD QUERY.—In my solution given last month, the full value of the constant k″ should have been given, as this varies with e and so alters the result. Professor Adams showed that to get the numerical value of the acceleration correctly it was necessary to introduce the variation of e into the differential equations, and not merely put in its rate of variation at the end. He in this way brought down the numerical value to about half what had been found before. The publication of his result excited a lively discussion among mathematicians, and it was some time before Adams' result won universal acceptance.

STELLAR MOTION AND SPECTRAL TYPE. — The study of the systematic motions of the stars has engrossed much attention in recent years, Professor Kapteyn taking the lead with his announcement of the two general drifts which could be detected when the motions were analysed. This announcement was confirmed and extended by the work of Mr. Eddington, Professor Schwarzschild, and others. Last year Mr. Hough and Dr. Halm examined the radial motions of the stars, derived from spectroscopic observations, and found that these too showed anomalies such as the two-stream theory would lead us to expect. Dr. Halm has recently (*Month. Not. R.A.S.*, 1911, June) returned to the subject and arranged the evidence in a manner which makes the conclusions more evident. After eliminating the solar motion he finds preponderance of motion in the direction of the vertices of the two drifts. The average motion taken without regard to sign is twenty-six kilometres per second in these regions, and goes down to fifteen kilometres per second at intermediate points. Dr. Halm's paper also contains further confirmation of the result already announced by Kapteyn and others that a star's velocity increases as its spectral type grows more advanced. Thus the Orion type, which is supposed to consist of very large and heavy stars, in a very early stage of development, has a mean motion of six kilometres per second in the line of sight; the Sirian type has eleven kilometres, while for later types the mean motion goes up to eighteen kilometres. The advantage of the spectroscopic method is that it is independent of distance; it is particularly valuable in the case of the Orion stars, which are so remote that their transverse velocity is difficult to ascertain.

Mr. Eddington, in a paper read before the British Association, reprinted in the *Observatory* for October last, refers to the above result as "one of the most startling in modern astronomy." He proceeds:—"For the last forty years astrophysicists have been studying the spectra and forming their systems by which they arrange the stars in order of evolution. . . . If this result is right we have a totally different criterion by which the stars are arranged in the same order. If it is really true that the mean motion of a class of stars measures its progress along the path of evolution, we have a new and most powerful aid to the understanding of the steps of stellar development."

BROOKS' COMET.—This was a most conspicuous object in the morning sky at the beginning of November. The tail was plainly visible for 20° or more. Rev. T. E. R. Phillips noted that its type appeared to have altered from the earlier one of a bunch of straight rays diverging from the head, to a parabolic envelope enclosing the head. There are good reasons for supposing that this latter type arises for comets when their distance from the Sun is small.

BORRELLY'S PERIODIC COMET will be visible in small telescopes during December. An ephemeris is given in "The Face of the Sky for January."

MARS has been a very brilliant object in Taurus, far outshining Aldebaran, the lucida of that constellation. From the reports of MM. Antoniadi and Jarry-Desloges it would appear that veiling by mist or cloud of portions of the dusky regions has taken place to an unusual degree at this opposition.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

STRUCTURE OF FLOWER IN CRUCIFERAE.—Arising from the preceding note, there may be considered some points in the morphology of the flower in the Cruciferae. The peculiar structure of the Cruciferous flower has given rise to a good deal of discussion, and the question is still open. As is well known, the flower shows isobilateral symmetry. The calyx is in two whorls, each consisting of two sepals; the corolla in one whorl, alternating with the calyx as a whole, with the four petals placed diagonally in a cross. The stamens are also regarded as being in two whorls, an outer whorl of two short lateral stamens, and an inner of four stamens in two pairs placed back and front. The pistil is apparently composed of two carpels placed transversely (laterally); the ovary is divided into two chambers by a partition joining the two placentas, the latter being placed back and front—this partition arises as an outgrowth of the placentas, the two outgrowths meeting in the middle of the ovary cavity; the two stigmas are placed above the placentas—a somewhat unusual position (the stigmas usually alternate with the placentas) but found also in the Poppy family (Papaveraceae). On the bases of the stamens are nectaries, the honey being secreted into the bases of the sepals.

From comparison with the Papaveraceae, which have two sepals, and from the fact that in development the four inner stamens appear to arise in pairs by branching of an outgrowth at first simple in structure, it has been supposed that the

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Cruciferous flower is fundamentally arranged in twos—that it is dimerous—and that the four petals and the four inner stamens are due to branching. This explanation has been widely accepted.

However, Klein (*Bot. Centralblatt*, Band 58, 1894) has urged that the Cruciferous flower is tetramerous—that is, primarily arranged in fours, not in twos. He bases this explanation chiefly on the position and course of the vascular bundles which supply the flower parts. Just below the flower itself, the flower-stalk shows eight bundles arranged in an ellipse. The first bundles to come off are at the ends of the long axis of the ellipse, and they go into the two transversely-placed sepals (though these are usually regarded as being the outer and first-formed sepals); the bundles for the two median (front and back) sepals come off higher up. Then, proceeding upwards, come four strands which proceed diagonally (answering to the position of the four petals); each of these strands soon branches into three veins, of which the median and thickest one enters a petal, while the slender lateral ones go into the neighbouring sepals—each sepal has, therefore, three basal veins (a thick middle vein and two slender lateral veins). The veins for the two short stamens come off next; then four more veins running in the diagonal direction and supplying the four long stamens.

From the arrangement of these veins, or vascular bundles, Klein concludes that the long inner stamens are diagonal in position, but have become approximated in pairs lying in the median (back and front) line, simply on account of the exigencies of space in the developing flower, due especially to the position of the nectaries. Klein, therefore, opposes the view that the four inner stamens have arisen by branching from two primordia situated in the median plane. Further up, there are two laterally placed veins, right and left, corresponding to the position of the two chambers of the ovary; and last of all come two veins lying in the median plane, which run up into the partition of the ovary. Klein regards these veins as belonging to two carpels which cannot develop owing to exigencies of space. Hence Klein considers that the flower parts are arranged in fours, with the theoretical formula K4, C4, A4 + 4, G (4). The outer whorl of stamens is incomplete on account of the development of nectaries in place of two of the stamens; the inner four stamens are arranged diagonally, being opposite the petals; and the two fully-developed carpels alternate with two abortive carpels.

In further support of Klein's view, it may be mentioned that in some Crucifers the four inner stamens are obviously diagonal, rather than arranged in two pairs (anterior and posterior); also that four carpels are present in genera like *Holargidium* and *Tetrapoma*, also in forms of *Capsella*, and in various cultivated and wild varieties of other genera.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON.), F.I.C.

A STALAGMITIC GROWTH IN SEA WATER.—An interesting case of the formation of mineral growths of a stalagmitic nature is described by Mr. T. Walton, in the current issue of the *Journ. Soc. Chem. Ind.* (1911, XXX, 1198). These were produced in an iron tank through which sea water had been flowing for several months for the purpose of cooling ammonia heated by pressure in a refrigerator. At several points in the pipe there were minute leaks, and the passage of the ammonia through these caused precipitation of some of the lime and magnesia in the sea water, and from the nucleus thus deposited upon the surface of the coil small columns of white mineral matter had gradually risen to the surface of the water. These formations ranged in length from five to fourteen inches, and from a quarter of an inch to three inches in diameter. Examined under the microscope they were seen to have a cellular structure, which was due to the pressure of the escaping bubbles of ammonia gas. The dried material composing these "stalagmites" consisted of eighty-eight per cent. of magnesium hydroxide, eight per cent. of calcium carbonate, 0·9 per cent. of calcium sulphate, and 2·8 per cent. of sodium chloride.

ESTIMATION OF THE AGE OF BLOOD STAINS.—A method of estimating the approximate age of blood stains has been based by Dr. de Dominicis (*Boll. Chim. Farm.*, 1911, L, 273) upon the rate at which they may be dissolved. A small portion of the stained material is immersed in pure glycerine, and the tube given a single shake at intervals of a minute until solution occurs. The yellow solution is protected from the air and compared with solutions obtained in the same way from blood stains of known age, the relationship between the colour of which and the time required for the solution is also known. It was found that blood stains which dissolved within one minute were undoubtedly of recent origin, while the longer the solution period the older the stain. The presence of blood in the solution should, of course, be proved by means of the spectroscope.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

THE NEW GLASGOW MEMOIR.—In continuation of the admirable policy of publishing maps and memoirs illustrating the geology of large centres of population, the Geological Survey has just issued a memoir and map of the Glasgow district. These have been specially prepared, as we are told in the preface, for economic and educational purposes with Glasgow as the centre of interest. An official description of this district was long overdue, for the old map (Sheet 30, Scotland), published in 1878, was not accompanied by a memoir.

As a centre for extraordinarily interesting and varied geology, Glasgow is perhaps unrivalled in the British Islands. Standing in a basin of Coal Measures and Carboniferous Limestone which is highly fossiliferous and replete with stratigraphical problems, it is surrounded, at a distance of a few miles, by an almost continuous rim of high volcanic hills, built up of igneous material of great variety and petrographical interest. To the north, at a distance of twenty miles, are the Highlands—an area of mystery likely to provide Glasgow geologists with work for many years to come. To the west the Clyde lochs and islands, including Arran—that favoured isle of perennial petrological interest—are easy of access. Also within an easy distance is the comparatively untouched area of Ayrshire, full of new material awaiting the geologist's hammer.

Under these circumstances the new memoir is very welcome, as providing a most valuable guide and groundwork to the geology of the district. The stratigraphical groups present in the area described range from Lower Old Red Sandstone to the Upper Barren Red Measures overlying the Coal Measures of Lanarkshire. In Calciferous Sandstone times a great volcanic episode occurred, which gave rise to the fine terraced lava escarpments of the Campsie and Kilpatrick Hills, flanked by numerous isolated, conical, volcanic recks. Towards the end of the Carboniferous period an interesting suite of teschenites was intruded into the Coal Measures of the east of Glasgow. Other rare igneous types are described, notably a bekinkinite from Barshaw, near Paisley; and a beautiful porphyritic essexite (long ago described by Allport) from Lennoxtown, both carrying conspicuous nepheline. A good nepheline phonolite has also been found near Fintry. The district is "full of petrographical material of the first importance," says Mr. E. B. Bailey, who has written the petrographical chapter; and we concur with his further remark that "the petrographical interest is likely to quicken rather than flag as the igneous rocks of Ayrshire to the west come to be examined."

A meritorious feature is the long chapter on economic geology, giving information as to coals, ironstones, fireclays, limestones and cements, setts and road-metal, building stones, brick-making and water supply, a list which illustrates the extent to which geology is a practical and applied science.

The colour-printed map is not so satisfactory as the memoir. It is extremely complicated, and looks as if colour-printing were being made to sustain an elaboration of detail of which it is not capable.

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METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

THE weather of the week ended October 21st, as set out in the Weekly Weather Report issued by the Meteorological Office, was at first fair and very warm, but became unsettled, with rains and thunderstorms. Temperature was very high in all districts, and the excess above normal amounted in places to over 8°·0, and at Birr Castle to as much as 9°·1. The highest readings reported were 68° at Guernsey, and 67° at Jersey and Margate. The minimum was below freezing point at only two stations, Balmoral 31°, and Nairn 30°. In the English Channel the temperature did not fall below 52°. On the grass readings of 26° at Crathes and at Glasgow were reported. Rainfall was below the average in most parts, but was in excess in Scotland W., Ireland and in England, S.E. At several places falls of upwards of an inch in twenty-four hours were reported, the greatest being 1·7 inches at Brighton on the 21st. Sunshine was less than average. The sunniest stations were Jersey 25·4 hours (34%), and Gordon Castle 25·3 hours (36%). In Sheffield the total duration for the week was only 1·2 hours (2%). The mean temperature of the sea water round the coasts ranged from 46·0 at Kirkwall to 58°·1 at Newquay.

Aurora was seen at Fort William on the 17th.

The week ended October 28th, was unsettled throughout. There was much rain, some snow or sleet in Scotland and many reports of thunderstorms. Temperature was in defect in Scotland, but was not far from the average elsewhere. The highest maximum was 62° at Westminster, on the 22nd, while minima of 32° or below were reported in all districts except the English Channel, where the lowest reading was 45°. The lowest of the minima were 21° at Fort Augustus and Kilmarnock. On the grass temperature fell to 16° at Llangammarch, and to 17° at Newton Rigg. Rainfall was less than the average in Scotland, N. and W., but was in excess elsewhere, very greatly so in the Channel Islands. Sunshine was in defect except in Scotland N. and in Ireland, but except in the extreme N. and extreme S., the difference was not large. Falmouth reported the largest aggregate, 28·4 hours (41%), Tenby coming next with 7·2 hours (39%). The mean temperature of the sea water varied from 45°·1 at Kirkwall to 57°·3 at Newquay.

During the week ended November 4th, the weather remained unsettled with frequent heavy rain. Thunderstorms were reported in the North. Temperature differed but little from the normal; the highest reading was 61° at Shields on the 30th, the lowest 15° at Balmoral on the 29th. On the grass, however, the minima were as low as 8° at Llangammarch, and 13° at Balmoral. Rainfall was in excess in all districts, except England N.E. and the English Channel. In Scotland it was from two to three times as much as usual. At Fort Augustus the total for the week was 6·49 ins., as compared with an average of 1·80 ins. Sunshine was in excess in the Eastern districts, but in defect in the West. The aggregate ranged from 31·1 hours (46%) at Felixstowe to 2·9 hours (5%) at Baltasound and Fort Augustus. The temperature of the sea water ranged from 42° at Kirkwall to 58° at Salcombe.

The week ended November 11th was also very unsettled. There were frequent rains but also bright intervals. Thunderstorms were observed over a wide area. Temperature was below the average nearly everywhere, the difference from average reaching 4°·0 in Ireland. The highest maximum was 61° at Tottenham on the 5th, the lowest minimum being 21° at West Linton on the 10th. In the English Channel the temperature did not fall below 40°. On the grass the lowest reading was 11° at Llangammarch.

Rainfall was in excess of the average in all districts except England, N.E. In England, S.E., and the English Channel, the total was more than twice the average. Bright sunshine was above the normal in all districts, the greatest excesses being in England, N.E., and the Midland Counties. Sheffield reported the highest aggregate, 32·0 hours (51%). At Greenwich the amount was 26·3 hours (41%). The temperature of the sea water varied from 40° at Scarborough to 55° at Newquay and Salcombe.

KITES IN THE UPPER AIR.—On October 21st a kite flown at Pyrton Hill, Oxon, from 10 a.m. to 10.30 a.m., reached a height of 1,600 feet, and experienced a very strong and gusty wind, during which the pull on the wire ranged from 10-lbs. to 180-lbs.

GEOPHYSICAL JOURNAL.—The Meteorological Office has commenced the issue of the *Geophysical Journal*, which comprises not only Meteorological Observations but also the daily record of observations of Solar Radiation, Seismology, Atmospheric Electricity and Terrestrial Magnetism. The contributing observatories are three in number, namely Valencia, Co. Kerry; Kew, and Eskdalemuir, Dumfriesshire. A feature of the publication is the introduction of the Centimetre-Gramme-Second System of Units for all the data. Thus the barometer readings are given in "bars," *i.e.*, megadynes per square centimetre, where one "bar" is approximately equal to the pressure of 750 mm. of mercury; temperatures are given in units on the Kelvin Absolute Scale, *i.e.*, in Centigrade degrees measured from a zero 273° below the freezing point of water; vapour pressure in "Millibars," and wind velocity in metres per second.

The *Seismological* data is for Eskdalemuir only, and is based upon the records of a Galitzin Seismograph, giving both period and amplitude of the microseisms. The Electrical data provided for include the potential gradient, the number of ions per c.c. and their velocity, the conductivity and the strength of the air-earth current. The Magnetic data are very full, and are based principally upon continuous automatic records.

It is believed that this is the first publication of its kind to be issued in any country.

MICROSCOPY.

By A. W. SHEPPARD, F.R.M.S.,

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD.
THE REV. E. W. BOWELL, M.A.
JAMES BURTON.
CHARLES H. CAFFYN.
ARTHUR EARLAND, F.R.M.S.
RICHARD T. LEWIS, F.R.M.S.
CHAS. F. ROUSSELET, F.R.M.S.
D. J. SCOURFIELD, F.Z.S., F.R.M.S.
C. D. SOAR, F.L.S., F.R.M.S.

THE INFUSORIAN MICRONUCLEUS IN REGENERATION.—The behaviour of the infusorian micronucleus in regeneration was dealt with by K. R. Lewin, B.A., in a paper read before the Royal Society, on November 2nd.

The variety of *Stylonychia mytilus* used was that possessing two micronuclei, and when a specimen is cut in two so that each merozoön receives one member of the meganucleus and one micronucleus, both fragments exhibit in favourable circumstances complete regeneration. This involves segmentation of the meganuclear member, and division of the micronucleus.

If a portion of the cytoplasm be removed from the hind end of the animal without disturbing the nuclei, there may occur during regeneration a division of one, usually the posterior, micronucleus. The result is to furnish the regenerated infusorian with three micronuclei instead of two, *i.e.*, the division does not restore but actually disturbs the nuclear relations characteristic of the race. When the regenerated individual proceeds to fission, all three micronuclei divide. That an extra division can be introduced into the normal cycle of mitoses shows that the organella is in a fit state to divide before the whole animal is ready for spontaneous fission; that the supernumerary mitosis occurs during regeneration suggests that the stimulus causing the micronucleus to divide may be the condition of the surrounding cytoplasm which obtains during the constructive activities of regeneration.

The cases in which regeneration occurs without either of the micronuclei dividing can be supposed to be those in

which either the micronuclei were not ripe for mitosis, or the stimulus was not sufficiently intense to evoke a division.

During normal fission when all the micronuclei present divide, there is a general formation of new parts, quite comparable with the localised activity in regeneration and accompanied, it is natural to suppose, with much the same condition of the cytoplasm. The mitoses occurring normally and those taking place during regeneration, can thus be brought under one point of view.

EUGLENA EHR.—Although such a "common object" as sometimes to be quite an inconvenience to the microscopist, *Euglena viridis* (Figure 1) has many points of interest which will repay rather more attention than is usually accorded to them. As with not a few other micro-organisms, in the past there has been much discussion as to whether it should be classed as an animal or as a plant. The modern view is that it partakes of the nature of both and may best be described as a plant-animal. Its possession of a mouth, and the ingestion of solid food, and its general activity entitle it to be looked upon as an animal; while its green colour, which is undoubtedly due to the presence of chlorophyll of the same character with that of plants, and the fact that it appears possible for it to exist without taking in food by the mouth, endorse its claims to be considered as belonging to the vegetable kingdom. Recently a small book under the name of "Plant-animals, a study in symbiosis" was published, describing two small worms (Convoluta) which display the same characteristics in a marked degree. The facts ascertained respecting these and the exhaustive experiments made on them prove conclusively that there are aquatic organisms, which, though unquestionably animals, yet owing to the inclusion of chlorophyll within them are able to, and actually do, obtain the carbon elements of their food, at least during a portion of their life, from the carbon dioxide dissolved in the water. The extent to which this capacity is possessed and exercised differs in various cases, but *Euglena viridis* certainly takes advantage of its endowment in this respect and so may be looked upon as a plant-animal. It has been suggested that the creature takes in nourishment during daylight as a plant by means of its chlorophyll, during the darkness feeding as an animal, but perhaps this idea rather exaggerates its voracity. It is not possible to make out the mouth and flagellum while the animal is swimming, but the careful application of a little iodine will kill it and bring them into view. The mouth is a funnel-shaped depression in the forward end—only capable of receiving very small particles—and from it springs the long, and during active life, swiftly moving flagellum (Figure 2a). The body is covered with a delicate cuticle, not sufficiently firm to prevent it readily changing shape; that represented at Figure 2b, is frequently assumed. The protoplasm is granular and the chlorophyll seems to be diffused in it, not collected into definite "chloroplasts." Many partially transparent bodies of considerable size are usually present; they resemble starch grains, but the substance composing them is known as ***paramylum***, and though having the same chemical composition as starch, is not coloured blue by iodine. A nucleus is present and near the usually distinct red "eye spot" a contractile vacuole. For the purpose of multiplication, towards autumn, or at any time on the occurrence of unfavourable conditions, *Euglena* may assume the encysted state. The body becomes spherical and a wall of cellulose (Jeffery Parker) is secreted round it. If the animals are present in great numbers—as is frequently the case—they adhere and form a kind of pellicle on the surface of the water. Blown by the wind, or moved by any object, this does not readily break up, but will crease and fold, just as the scum on boiling milk does. Later the animals may resume their active state, and the cells which contained them (at first circular, but afterwards, owing to pressure and movement, angular and mis-shapen) are left adhering together, and have exactly the appearance of a cellular membrane (Figure 1). This persists for some time, and various floating aquatic organisms make it their home. It has been mistaken for, and described as, some kind of alga. During the past summer this object has often been noticeable on the surface of ponds as a brownish delicate film. While resting encysted the individuals may undergo division into two or four smaller specimens, but of the same shape as the adults, so that on emergence their numbers are greatly increased. Figure 2c, "An interesting local variety of *Euglena viridis*, has been described by Mr. M. H. Robson, of Newcastle-on-Tyne, in *Science Gossip*, October, 1879, in which the distal extremity of the flagellum presents an inflated knob-like aspect." Figure 2d: The same singular variety has recently been recognised in some ponds near London.

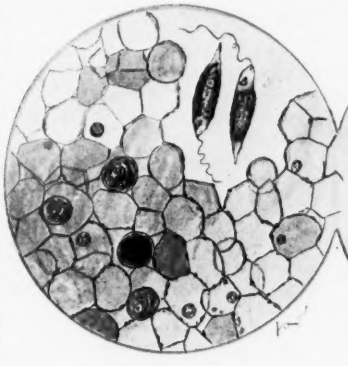


FIGURE 1.

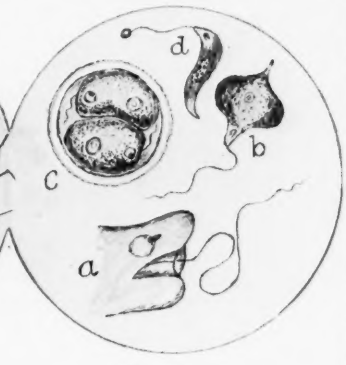


FIGURE 2.

Figure 1 is from a specimen which lasted several weeks in a saucer of water after being brought from a pond. The membrane is represented on the same scale as the two animals above. Figure 2 is from Saville Kent's Infusoria, a and c highly magnified.

J. BURTON.

AMPHIDINIUM OPERCULATUM CLAP AND LACH.—In the Journal of the Linnean Society, vol. XXXII, pages 71–75, Professor W. A. Herdman, F.R.S., describes the occurrence of this little peridinian in vast quantities in Port Erin Bay (Isle of Man). The hollows of the ripple-marks and other slight depressions formed by the water draining off the beach were occupied and outlined by a greenish-brown deposit which in places extended on to the level, so as to discolour patches of the sand. Here the deposit remained more or less for a month, waxing and waning, sometimes increasing in the tide, say, roughly ten-fold, and at other times apparently disappearing for a day or two and then reappearing either on the same part of the beach, or it might be a few hundred yards away. At one time it coloured a continuous stretch of sand about fifty yards long by five yards in breadth just below high-water mark, and was noticeable for some distance away. On examination the deposit was found to consist of vast numbers of *A. operculatum*. This peridinian was first described by Claparède and Lachmann, in 1858, from specimens obtained in some few places in Norway, and according to a recent authority is found occurring in brackish water on the North Coast of Europe, but has not been previously recorded for the British area. It was first observed at Port Erin early in the year, but later brown patches of similar appearance were again observed on the sand; on examination these were found to consist of vast numbers of a golden-yellow naviculoid Diatom. The Amphidinium had disappeared, but re-appeared in abundance by September.

Under observation *A. operculatum* swims about freely, but soon comes to rest by attaching itself to a sand-grain. It is positively heliotropic and collects in quantity on that side of the dish which is turned towards the light. Multiplication by fission was frequently observed. Its greatest diameter is 0·05 millimetres.

QUEKETT MICROSCOPICAL CLUB.—October 24th.—Professsor E. A. Minchin, M.A., F.R.S., President, in the chair. An old microscope, sent by Mr. Hugh Paterson, of Sydney, N.S.W., was exhibited. It had been presented, about 1850, to his father, by J. T. Quekett, F.R.S. (1815-61), the distinguished microscopist, after whom the club is named.

E. M. Nelson, F.R.M.S.—"An improved compound microscope, by James Mann, 1751," was read by the Hon. Sec. The instrument is, in the main, obviously a copy of J. Cuff's (1744), the improvements consisting in the mirror and its attachment, and in making the instrument portable. The first portable compound microscope was made by George Adams, in 1746, and the one now described showed Mann's device for adapting Adams's idea of portability to Cuff's microscope. Very probably this was the second portable microscope.

J. W. Shoebotham, N.D.A.—"A general account of the Spring-tails (Collembola)." They were described as belonging, with the orders Protura and Thysanura, to the sub-class Apterygota, of the class Insecta. The anatomy of the Collembola was described fully, accounts being given of the eyes, post-antennal organ, pseudocelli, antennal organs, body, legs, and those very typical and curious organs, the ventral tube and the spring. A tracheal system is usually absent and in the few species possessing one it is very poorly developed. Although they have generally been regarded merely as scavengers, there is now evidence to show that they may do considerable damage to growing crops. Between four hundred and five hundred species are at present known, of which one-hundred-and-seven have been recorded from Britain.

Messrs. Watson & Sons exhibited under microscopes an interesting series of preparations of embryos of Decapods.

THE ROYAL MICROSCOPICAL SOCIETY.—October 18th.—H. G. Plimmer, F.R.S., President, in the chair.—T. W. Butcher: Structural details of *Coscinodiscus asteromphalus*. A paper describing the primary areolations with the secondary and tertiary markings, illustrated by a series of lantern slides made from photomicrographs obtained at a magnification of one thousand one hundred. In addition slides were shown demonstrating a fine siliceous network or veil lying upon the outer surface of the valve, and others in series, from photomicrographs taken, at five or six consecutive foci, of the hexagonal cell layer with its "ringed" openings of Morland, to prove that these openings are clear and not obstructed by the finely perforated membrane recently reported by Mr. Nelson (*Journ. R.M.S.*, October 1910). The membrane being non-existent, its value as a test for a high-power lens is *nil*.—Rev. Hilderic Friend: New British Enchytraeids. *Enchytraeus minimus* Bret. was described in the *Rev. Suisse de Zoologie* in 1899. Michaelsen, in *Das Tierreich*, 1900, suggested that it might be one with *E. argenteus* Mich. (= *E. parvulus* Friend). Bretscher examined the subject again in 1902, and decided that the two were distinct. The author, who had already described *E. argenteus*, has found *E. minimus* at Buxton, and holds with Bretscher. *Fridericia peruviana* n. sp. was received in earth from Peru and submitted to the author by the authorities at Kew. It is 5–6 mm. in length, has 2-5 setae which are somewhat larger behind than before. Brain slightly concave posteriorly; oesophagus sharply marked off from intestine; dorsal vessel postclitellian in origin with dilatations in segs. 7-9. Salivary glands not branched; long.—Walter Bagshaw: Instantaneous exposure in photomicrography.—Flashlight illumination has been put to a novel use by Mr. Walter Bagshaw, F.R.M.S., for the photography through the microscope of objects in motion. A good negative of freshwater polyzoa, (*Lophopus crystallinus*) expanding its tentacles, was secured by a charge of "Agfa Flashlight Powder" in one-thirtieth of a second. Gatherings of Pond-life, such as diatoms, larvae, water fleas, also yielded successful results. Provision was made for replacing the ordinary lamp by flash powder put in the position previously occupied by the centre of flame, and ignition made with a red-hot wire.

ORNITHOLOGY.

By HUGH BOYD WATT, M.B.O.U.

BLACK REDSTART REPORTED NESTING IN ENGLAND.—It is stated that the Black Redstart (*Ruticilla titys*) has been identified as nesting in the Keswick district this season (1911). Very conclusive and convincing evidence is, however, necessary before this species can be admitted to the list of British nesting birds. In past years supposed eggs have been obtained or observations made in different localities (Sherwood Forest, in 1854 and 1856; Dumfriesshire in 1858 and 1889, and Hertfordshire in 1876), but in no case has the identification as to nesting been accepted as satisfactory. The bird's habitat is central and southern Europe, and the seasons of its annual occurrence in England are autumn and winter, although in a very few instances it has been found at other times. This distribution is rather curious, as it is only a summer visitor in central Europe, and has not so high a northern range as the Common Redstart (*R. phoenicurus*), which appears throughout all Europe in summer, and is not known in the British Isles at any other season of the year. The point is, that the summer Redstart in Britain is the more northern species, but the visitant Redstart seen in autumn and winter is the southern form (*R. titys*).

THE STARLING AS A MIMIC.—A correspondent, Mr. Basil T. Rowsfell, writing from St. Martin's, Guernsey, says that on 22nd September last he was astonished to hear what was apparently a Wryneck's call from a tree in his garden there, clear and distinct, as it may be heard in spring and early summer. This was repeated for some days up to 6th October, and, by carefully watching, Mr. Rowsfell made out that the calls came from a Starling (*Sturnus vulgaris*). He suggests that this particular bird may have been reared in the immediate vicinity of a Wryneck's nest, and caught the note from the parent Wrynecks.

Starlings are, of course, well known as mimics. The wailing whistle of the Common Curlew (the Whaup of northern districts) is associated with wild and lonely places, but we have known a Starling to give a very passable imitation of this call from the house-tops of a great city. This individual bird, or another which had also picked up the trick, returned to the same place a second winter and brought moorland echoes with it, amongst thronging people and crowded houses.

THE NATIONAL COLLECTION AT SOUTH KENSINGTON.—According to the "Return" presented to Parliament of the British Museum for the year 1910, the additions made to the great bird collections at the Natural History Museum amounted to 9377 specimens in the year named. These came mostly from Asia, Africa and South America, and several of the collections consist of some hundreds of items. The most extensive is 1346 birds, nests and eggs from Angola, Portuguese Guinea, and the Cape Verde Islands, obtained by Dr. W. J. Ansorge.

PHOTOGRAPHY.

By EDGAR SENIOR.

THE article in "Notes" of last issue contained a description of the use of a pin-hole in place of a lens, and was illustrated by an excellent photograph taken by its means. It may, therefore, be of interest in connection with this subject, to just consider "on theoretical grounds," the conditions which govern the use of plain apertures, in order to obtain the best results with them in practice. It is well known that photographs taken by means of a plain aperture in place of a lens, possess advantages over those taken with the lens, in so far as distortion is entirely absent, and the artistic effect obtained is extremely pleasing. It is also well known that for a given aperture an image will be obtained at whatever be the distance from it to the plate; but it was proved many years ago by Lord Rayleigh, as a consequence of the Wave Theory

of Light, that the best definition is obtained when the diameter D of the aperture is related to the distance L from it to the plate, as given by the equation

$$D = 2\sqrt{\lambda L}$$

where λ is the wave length of the light employed.

Taking into account the wave length of light of maximum photographic activity, Sir William Abney gives the formulae

$$D = \frac{1}{120}\sqrt{L}$$

where D and L are measured in inches. It was proved by Lord Rayleigh that when the conditions specified by his formulae are complied with, no further improvement could be obtained. We have before us as we write a photograph taken by means of a plain aperture, in which the conditions set forth above were fulfilled. The distance of the plate was nine inches, and from our formulae $D = \frac{\sqrt{9}}{120}$ we obtain $\frac{1}{40}$ inch as the diameter of the aperture that would give the best definition with the plate placed at nine inches from it.

COLOUR PHOTOGRAPHY UPON PAPER.—However beautiful may be the colour photographs in the form of transparencies upon glass, there is still the feeling among a large number of persons that the only really satisfactory solution of the problem of photography in colours will be found in a process which is applicable to paper. Quite recently the attention of photographers has been drawn to a new paper which has been placed upon the market for the purpose; prepared by Dr. J. H. Smith. The general principle upon which several experimentalists appear to be working is that suggested by Wiener, who considered that the chromo-sensitive surface should be black, and composed of, at least, three physical elements. The writer experimented in this direction some few years ago, employing paper coated with red, yellow and blue dyes. The dyes being fugitive, the prepared paper was found, after exposure under a coloured transparency, to give a fairly good rendering of the object, although in every case the time necessary to obtain the results was very prolonged, amounting to days in the strongest light. To what extent this and other difficulties may have been removed we are unable to say, as we have not had an opportunity of trying any of the recently prepared papers.

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

POSITIVE IONS FROM HOT SUBSTANCES.—These have been the subject of numerous investigations recently. Professor Sir Joseph Thomson found that aluminium phosphate gave off a large number of positively-charged particles when deposited on a platinum strip which was heated to about 1000°C. Garrett and also Horton have investigated the effect and have shown that the production of these positively charged ions is intimately associated with the production of small quantities of carbon monoxide—a very commonly occurring substance in vacuum tubes submitted to the electric discharge.

Professor Richardson has investigated the carriers of positive electricity from strips of platinum coated with alkalis and alkaline earth metals. He finds evidence to show that these carriers are atoms of the metal carrying a single charge. Even the divalent metals carry only a single positive charge, which is contrary to what might be expected, since these metals are chemically equivalent to two atoms of hydrogen. The heated platinum itself gives off a certain number of charged ions and Professor Richardson has investigated this thoroughly. He suggests that the considerable discharge of positive particles from aluminium phosphate is due to the impurity of alkali metals it contains. These positive ion discharges are not nearly so marked in effect as the negatively charged particles emitted by the alkaline earth oxides. If a small piece of sealing wax be allowed to coat a platinum strip mounted in a vacuum tube so that an electric current can be passed through it, and if there is a difference of potential of 100 volts or thereabouts, between the strip and another electrode in the tube, then on heating the wax, only lime and barium oxide is left which causes a copious discharge of negative corpuscles. Professor J. J. Thomson has utilised these discharges to obtain steady striations in a vacuum tube and by investigating the behaviour of a cathode ray beam from a side tube as it passes transversely through the electric field in various portions of the striated discharge, he has been able to find the magnitude of this electric field, and hence show that the striations are due to the crowding up of corpuscles. The collisions of these with the ions of the gas cause the latter to radiate light. From these areas of collision corpuscles acquiring great velocity are shot off in the direction of the positive electrode and until, by collision with the gas molecules in the tube, their velocity is reduced to such an extent that they can no longer keep on in a straight path, there exists a dark space. Thus a striated discharge comes about; the number of striations depending on the pressure of the gas in the vacuum tube.

When an electric discharge is passed through a gas at low pressure, it has long been questioned whether the gas is electrolysed; that is, suppose one passed an electric discharge through hydrochloric acid gas, would hydrogen be found in greater concentration at the cathode and chlorine at the anode, as in the electrolysis of the aqueous acid. Professor Thomson many years ago succeeded in obtaining the hydrogen spectrum at the cathode and the chlorine at the anode and on reversing the current the hydrogen and chlorine changed places, the hydrogen still being found at the cathode. However Kayser, the illustrious author of the "Handbuch der Spectroskopie," has asserted that these effects are due to thermal effects, the cathode being always hotter than the anode. Recent experiments at the Cavendish laboratory have apparently shown without doubt that a separation of an electrolytic nature does occur, but that the effect is upset by the mobility of the gaseous ions and consequently thermal effects come in to a great extent. Many organic halogen compounds have been investigated, and the chlorine is sometimes found at the anode and sometimes at the cathode, but as a rule exactly in accordance with its chemical behaviour, either as an anion or cation. In a compound such as methyl sulphide, sulphur would be found at the anode and the carbon monoxide spectrum at the cathode. These results have been obtained by Mr. G. Stead.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

ASSOCIATION OF CRAB AND HYDROID.—Everyone knows that many animals grow upon others in an accidental sort of way, because the young stages landed there. This is a fortuitous epizoic association. Sometimes, however, the association, though remaining entirely external, is by no means fortuitous; thus many spider-crabs pluck hydroids along with sea-weeds from their surroundings, and plant them on their shells, with the result that they are "masked." Different from this again is a case like the following, recently described by Dr. W. T. Calman, whose delightful introduction to Crustaceans ("The Life of Crustacea," Methuen, 1911) should be read by all interested in Natural History. A crab from Christmas Island showed a hydroid polyp, allied to Stylactis, attached like a tassel at the "knee" of each of its legs. This is interesting in several ways. All but two of the polyps were symmetrically disposed; the type specimens of the species (*Medaeus haswelli*) to which the crab belongs, although coming from a distant locality, were found to bear a similar or identical hydroids; the crab is a Xanthid, not one of the spider-crabs in which masking is common; even the rootwork or hydrorhiza was very precise in its occurrence, following the inter-regional grooves on the carapace.

XUM

A PRIMITIVE ANT SOCIETY.—There is a Mediterranean ant, *Aphaenogaster sardoa* by name, not uncommon in Sardinia, which illustrates a simple type of societary form,—simple, at least, as ant-societies go. It has been recently studied by Dr. Krause-Heldrungen, who describes the way in which the ants huddle together in living balls, interlocked with mandibles and tarsi, and holding the eggs, larvae, and pupae in the centre. An average society consists of three hundred to a thousand individuals; the males have not been found; and the observer found only one queen. Architectural construction is at a minimum; they use holes in the ground. They do not store and they have no guests. Huddling together in a ball is their form of sociality. In winter the ball is very stiff and is slow to relax when it is unearthed. In summer, naturally, it is more plastic, being made and unmade several times a day.

BLOOD-SUCKING MAGGOTS.—There is a fly called *Auchmeromyia luteola* (Fabr.), whose larvae have the remarkable habit of piercing the human skin and sucking blood. This has been hitherto a quite unique thing, but E. Roubaud has found its parallel in a related African form, for which he establishes a new genus *Choeromyia*. One species lives in the burrows of the Cape Ant-Eater and another along with the Wart-hog. The flies eat dung and like darkness. The larvae live in the damp ground; they are able to fast for a long time; they are attracted to the warmth of their hosts; they fix themselves on the skin, pierce it, and suck blood. They can ingest three times their weight of blood, Roubaud reared one on himself.

BEETLES IN NESTS.—Heinrich Bickhardt has collected the available information in regard to what he calls "nidicolous" beetles—those which live in the nests of birds and mammals. There are no fewer than twenty-eight which are found exclusively in nests. A much longer list is given of those that usually occur in nests, but also in other suitable places Besides these there are casual visitors. Of the exclusively nidicolous beetles, eighteen are confined to the homes of Mammals, such as mole, hamster, mouse and rabbit; seven are confined to the nests of birds, such as dove, sand-martin, owl, and woodpecker; three are found associated with both birds and mammals.

INNERVATION OF WINGS IN LEPIDOPTERA.—R. Vogel has made a study of the rich innervation of the wings in butterflies and moths, and shows how rich the wings are in sensory structures. There are tactile scales and (probably) tactile spines. There are peculiar papillae, which may have to do with orientation in flight, and "chordotonal organs" like those which distinguish notes in various Orthoptera. Altogether the wing is an exquisitely sensitive structure.

SOLAR DISTURBANCES DURING OCTOBER, 1911.

By FRANK C. DENNETT.

THE falling off in solar disturbance shown last month was equally noticeable during October. Observations were made on twenty-nine days, the omissions being on the 16th and 27th. On fourteen days the disc presented an even brilliance, save for the delicate granulation, these being October the 9th, 10th, 13th until 15th, 17th until 21st, 24th, 26th, and 28th until 31st. On the 1st and all other dates after the 10th only faculic disturbances were seen. The central meridian on October 1st was 289° 42′.

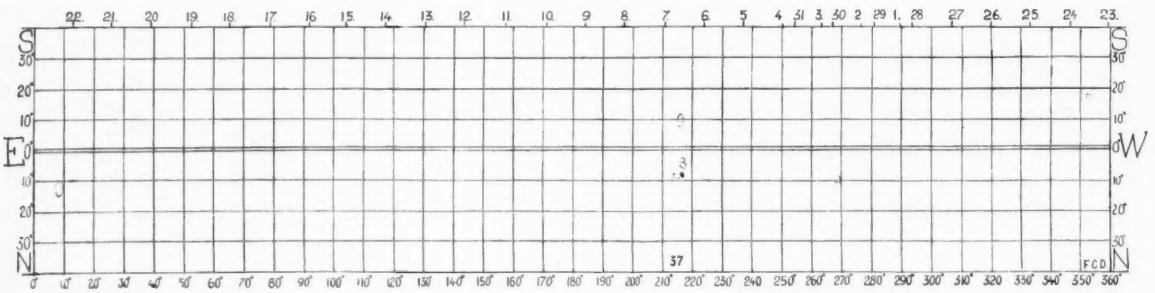
No. 37.—Two brilliant curved ridges of faculic matter formed a striking object a little within the eastern limb of the Sun on October 1st, like the borders of an elliptical disturbance. On the 2nd in place of the western ridge a dark spot having two umbrae had developed, whilst three pores were embedded in the eastern ridge. Next morning the spot had become 10,000 miles in diameter, and the number of pores had reached seven, the group being 30,000 miles in length. Only two of the pores were seen following the leader on the 4th. By the 6th the leader enclosed two umbrae, whilst one pore showed 10,000 miles behind and a second nearly two degrees south of the leader. On the 8th the leader, reduced to a pair of umbrae, was alone, and had quite disappeared before next morning. The spectroscope showed a considerable amount of activity around this group indicated by dark hydrogen flocculi extending for a long distance. On the 6th there was a considerable prominence visible, projected on the bright surface, a little south-east of the spot, whilst the whole region showed traces of helium by the presence of the dark line known as D_3.

The dotted areas indicate the positions of faculic disturbances. On October 2nd a small bright knot was visible near longitude 353°, S. latitude 17°. On the 8th there was a small knot at 269°, N. latitude 5°. On the 11th and 12th two separate faculic disturbances were visible near the western limb, one double group closely ahead of the place where the spot group, No. 37, had disappeared, whilst the other was on the other side of the equator. On the 22nd and 23rd there was a faculic district about longitude 10°, and 10° N. latitude. On the 25th there was a group of greyish pores in a disturbed area near longitude 280°, but careful measures were not possible.

The Prominences are much fewer in number than was the case only a few months since. The most remarkable one appears to be a very tall spindle at 20° South-east, seen on October 21st.

Our chart is constructed from the combined observations of Messrs. John McHarg, A. A. Buss, E. E. Peacock and F. C. Dennett.

DAY OF OCTOBER, 1911.



REVIEWS.

EVOLUTION.

Convergence in Evolution.—By Dr. Arthur Willey, D.Sc., F.R.S. 177 pages. 12 illustrations. $8\frac{3}{4}$-in. × $5\frac{1}{2}$-in.

(John Murray. Price 7/6 net.)

Dr. Willey writes, he says, so as to be intelligible to those who have an inkling of biological knowledge, but it is probable that his argument as a whole will hardly be appreciated save by trained zoölogists. Nevertheless, there is an abundance of facts recorded, many of them new and all interesting, that should appeal to every naturalist however much of an amateur he may be; and it is safe to say that even a professional zoölogist will learn much to his advantage. The author sets out by reviewing certain points in the growth of the science of morphology and its kindred branches which have rendered them valuable both as intellectual recreations and as of direct practical use to mankind. He goes on to suggest that we may look to other properties of animals besides those of structure to gain a comprehensive survey of the animal kingdom. Without going so far as to compare the value of classification based on structure with that based on similarity of function, he asserts that too little attention has been paid to what may be called physiological systems of classification. Air breathers, and water breathers, fixed forms (statozoa) and free forms (eleutherozoa), light avoiding habits (cryptotaxis), and light seeking habits (phanerotaxis), and so on, are compared together, with a host of interesting and illustrative facts of natural history, many of them personally observed by the author. Similar habits and environment have brought about similar structure; in other words, convergence and parallelism have been far more potent factors in evolution than is generally believed, and the same structure in homogenous animals has nevertheless often been independently acquired. Especially applicable are his ideas of convergence, divergence and parallelism to the parallel series of marsupials and placentals: perhaps the most convincing argument in the book. According to Dr. Willey, convergence may be traced in the anatomy, bionomy, physiology and histology of animals closely related and widely dissimilar, *e.g.*, the pectoral fins of flying fishes, and the solenocytes of Amphioxus and the Polychaetes, to take but two examples. He might also have added psychology as well. Nothing is clearer from the results of anthropological research, than that the different races of men, separated by the whole length of the globe, have evolved almost, if not quite, the same myths and folk-lore, independently of one another.

Nevertheless it must be confessed that the ordinary zoölogist will not feel that his cherished beliefs and traditions have been seriously undermined by Dr. Willey's book. The true test of relationship of animals must be based on the structure of modern and extinct forms, and this fact Dr. Willey would himself probably be unwilling to challenge; and although such eminent writers as Dr. Gaskell, whose theories as to vertebrate origin the author extensively quotes to refute, may be led into situations where the finding of homologies based on structural resemblance takes on an almost terrifying aspect, yet the main principle holds good.

Here and there, *e.g.*, on page 10, it is not easy quite to understand what is meant, but, as a whole, the book is clearly and brightly written.

M. D. H.

Neglected Factors in Evolution.—By H. M. Bernard. 489 pages. 47 illustrations. $8\frac{3}{4}$-in. × $5\frac{1}{2}$-in.

(G. Putnam's Sons. Price 12/6 net.)

It not infrequently happens, and this book is a case in point, that a biologist after years of work in some more or less restricted branch of his subject, it hardly matters what, proceeds to the most far-reaching generalisations. We are far from deploring this tendency, though at times it is accompanied by a want of sense of proportion, patent to all save the author himself. For it is an undoubted fact that careful observations even of a limited scope, coupled with sound reasoning and a sufficient dose of imagination, have in the past, as they will in the future, revolutionized biological science. We leave our readers to decide for themselves if this is true of Mr. Bernard's work. The author is chiefly known for his researches on the histology of the retina, and on the morphology of the apodidae and of other arthropods.

The book is divided into two parts. The first, however much we may disagree with the conclusions therein arrived at, is a valuable contribution to cytology. It is clearly written throughout, and Mr. Bernard never forgets the point of view which most biologists hold on the Cell Theory. That the facts observed necessarily prove the theory does not follow, though there is much to be said in support of it, yet the author's careful summary of the facts in itself is a valuable piece of work. A long study of the minute structure of the human retina convinced him that the views commonly held as to the fundamental nature of tissues in general are untenable. In common with Whitman, Sedgwick, and others, he refuses to look on cells as the lowest units of life. The structure of bacteria and of some protozoa, and the histology of the metazoa prove, he thinks, that organisms are not made up of cells but of smaller units, which he calls chromidia. A cell is simply a complicated tangle of chromidia, and cell-boundaries are always indefinite and of little importance. In fact protoplasm is made up of a network of living threads, visible only when they are coated with some stain-receiving matter, on which are threaded lumps of chromatin. This latter substance he believes to be chiefly made of complex chemical bodies necessary for the life of the filaments. A simple chromidium consists of a small lump of chromatin provided with a number of radiating threads along which it can creep backwards and forwards, bathed in a nutritive albuminous matrix. He points out that such a view of cell structure brings into harmony the well-known views of Bütschli and Altmann as to the structure of protoplasm; with great ingenuity he applies this conception to explain not only the structure of a typical cell, but of cilia, flagella, ecto- and endo-plastic skeletons, and even the phenomena of mitosis. Though in justice to the author it should be remarked that few difficulties are shelved, yet more attention should have been paid to the discoveries of the "Entwickelungsmechaniker." The fact that isolated blastomeres of developing eggs can produce a perfect though much reduced larvae hardly squares with his theory. Mr. Bernard believes that the cell theory in its present shape stands in the path of further progress in cytology, while his theory of a primitive network, protomitome, pervading the whole organism, certainly does away with some of the difficulties attending a comprehensive understanding of tissue formation. Furthermore, we are shewn the way in which the metazoa might have been evolved from an unicellular ancestor. All this is very interesting, and, if not convincing, is at all events well worth reading.

Part 2 contains far more theory and less fact. Postulating a kind of rhythm in evolution, the author suggests that the factors according to Darwin are insufficient to explain the gradual development of a highly differentiated organism such as Man. He believes that evolution has been marked by periods at the end of each of which an outburst of activity has taken place resulting in colony formation. A colony of chromidial units becomes a cell, a colony of cell units becomes a gastrael unit, a colony of gastrael units forms an annelidan unit. Some such creature as an annelid gave rise in the process of evolution to vertebrates, culminating in Man himself. The fifth evolutionary colony formation has Man as its unit, the colony itself being human societies. Just as the physical bodies of all the five units consist of a

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network, so are the units of human societies joined together by a psychical network, invisible perhaps, but connecting man to man. The physical network that exists between a mother and her unborn child is broken at birth, but a psychical network connects them both until death, and perhaps hereafter. Thought transference is taken for granted as an established fact; and it is hinted that in another stage of existence, or possibly in this, more and greater bursts of evolutionary activity may be in store for the human race.

In conclusion, we may cordially recommend Part 1 to the notice of biologists, even if they do not agree with Mr. Bernard's views. As to Part 2 it is harder to speak. We ourselves believe that the time is not yet ripe for such speculations, and although most biologists will pause to think from time to time over such matters as the connection of the physical with the psychical, materialism and vitalism, and kindred speculations, which the study of living matter arouses, it does not necessarily follow that much will be gained by giving them to the world at large.

M. D. H.

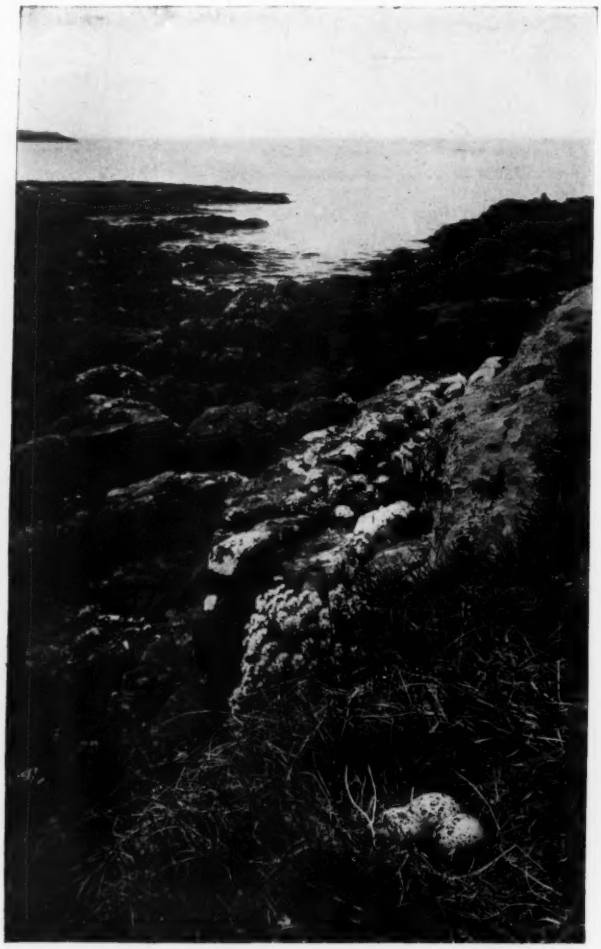
The Evolution of Painting: A History of Painting in Italy.— By J. A. CROWE AND G. B. CAVALCASELLE. Vol. IV. 379 pages. 54 illustrations. 9-in. × 6-in.

(John Murray. Price 21/- net.)

It is with the greatest satisfaction that every student of painting, as well as those who are interested in art for its own sake, will receive the intimation from Mr. John Murray that the re-issue of Crowe and Cavalcaselle's great work is now on its way to a satisfactory completion. When Mr. Crowe and Signor Cavalcaselle wrote their volumes, the study of Italian painting was the privilege of a few, and the occupation of a yet more limited band of enthusiasts; the photograph and the cheap trip were alike remote. But the genius, the industry, and the visual memory of these two men were capable of producing a treatise on the subject such as remains an unassailable masterpiece; and though the books on Italian Masters are almost as numerous as the picture post cards which the twentieth century tourist in Italy brings or sends home as mementoes of the paintings he has seen, none of them has the unique authority and comprehensiveness which this work attained. Nevertheless, the demand for information must evoke a supply, even of pictures and the whereabouts of pictures. One might almost go so far as to say that the demand for new knowledge must sometimes confound the old, so that an attribution which seemed perfectly reasonable when Crowe and Cavalcaselle wrote is rightly subject to revision as other pictures come to light; and it is certain, that human taste being not infrequently only the essence of generally received opinions, the artistic values set on Old Masters, especially on minor Old Masters, must be subject to alteration. A new edition of the volumes must therefore be a work much larger than the old, much more valuable than the old, much better illustrated than the old; and the chief difficulty of the publisher must be to find editors sufficiently catholic to admit the new material, sufficiently eclectic to prevent a lowering of the standard.

In the fourth of the six volumes in which the work is to be completed, and which deals with Florentine Masters of the Fifteenth Century, these requirements are as faithfully fulfilled under the editorship of Mr. Langton Douglas assisted by Mr. G. de Nicola, as they were in the earlier volumes, when Mr. Douglas had the collaboration of Mr. Arthur Strong. It is in many ways the fullest of the volumes hitherto issued; and the new notes and references are on a scale which almost adds an additional volume to the original work. The remaining two volumes are promised during the next year, and the only satisfactory and complete handbook on the development of Italian painting will be within the reach of persons of moderate means.

E. S. G.



From "Photography for Bird Lovers" by Bentley Beetham.

An Oyster Catcher's Nest. A suggestion of the Bird's Habitat.

Photography for Bird Lovers. — By BENTLEY BEETHAM, F.Z.S. 126 Pages. 18 illustrations. $8\frac{1}{4}$-in. × 6-in.

(Witherby & Co. Price 5/- net.)

The accompanying illustration, which we reproduce by the courtesy of Messrs. Witherby & Company, shows how carefully Mr. Bentley Beetham has studied his subject, and how much he is able to put into his pictures, for the photograph which has been reproduced not only shows the nest and eggs of the Oyster Catcher, but also indicates in no small degree the kind of site which the bird selects. The book consists chiefly of instructions telling the would-be bird-photographer how to proceed. After apparatus has been dealt with, the photographing of nests and young birds, the use of stalking and concealment methods, not to mention rope work on the cliff faces, the taking of birds in flight, in colour, and by means of the cinematograph are considered. It is truly surprising how much information and how many beautiful photographs have been included in this small volume.

PSYCHOLOGY.

Body and Mind: A history and a defence of Animism.— By WILLIAM MCDOUGALL, M.B. 384 pages. 13 illustrations. 9-in. × $5\frac{3}{4}$-in.

(Methuen & Co. Price 10/6 net.)

This book, as we are informed in its preface, contains "a critical survey of modern opinion and discussion upon the

psycho-physical problem, the problem of the relation between body and mind." Its author has clearly done his utmost to present his material "in a manner not too dry and technical for the general reader who is prepared to grapple with a difficult subject," and truly the subject is a difficult one. Nevertheless, the writer must be warmly congratulated on his bold attempt to make clear that which is to most so obscure, for the definite line of argument which pervades the whole book will make it difficult for any reader who systematically studies it to miss the author's meaning on any one of its closely covered pages. The book is a book for students, amateur and professional, and may be described as a scientific defence of Animism, the theory of the existence of the soul. The author clearly shows that there is no alternative between Animism and the most absolute Materialism, and boldly stands for the former; indeed the present volume is perhaps the first really scientific attempt to justify the soul theory. But it is much more than this, for the first half at least is occupied with a "survey of modern theories of the psycho-physical relation," and without this the reasoning of the later chapters is almost impossible to follow.

The book is clear and concise and excellently written, and though wholly unsuited to the casual reader is most emphatically to be recommended to anyone of average intelligence, who has made up his mind to systematically grapple with this difficult but interesting subject.

PHYSICS.

Treatise on Practical Light.—By REGINALD S. CLAY. 519 pages. 408 illustrations. 8-in.×5½-in.

(Macmillan & Co. Price 10/6 net.)

Dr. Clay's treatise which is an enlargement of his well-known "Practical Exercises in Light," is a book which will be welcome to many. There are many books which deal with optics from a theoretical point of view, from a geometrical standpoint or as an entertaining subject for the lecturer. There has long been required a book which collects together the various methods of optical measurement. Works on Practical Physics contain sundry optical measurements, but seldom can one find just that process of measurement that one requires. Dr. Clay in his introduction says, "There can be no doubt that it is to the advantage of the optical industry both that the difficulties manufacturers find should be known to those whose scientific training may assist in their solution, and also that the experimental methods which have been adopted by individual manufacturers should be known to each other, as well as to those whose interest may be chiefly theoretical. The chapters on aberration of lenses and mirrors and on the compound lens illustrate the above statement, and show that the author has written a book which comes up to these excellent ideals.

The book commences with a chapter on simple pin experiments—some most useful, such as the determination of the angle of the surfaces of a piece of nearly parallel glass, and all very instructive to the beginner. This leads up to a chapter on the position and nature of images formed by mirrors and lenses, dealt with in a simple manner; and then more completely in a chapter on the focal length of lenses and mirrors which contains many valuable methods and even means of obtaining the radius of curvature of very small lenses as used for microscope objectives. Chapters follow on optical instruments, deviation and dispersion of light, the velocity of light, and focal lines. The adjustments of the spectrometer are well described; it is such descriptions that make a practical treatise of good value, and it would have been pleasing to have found a rather fuller account of the method of working refractometers, spectrophotometers, and other refined optical appliances. The author's admirable love of simplicity causes him to omit fuller descriptions of instruments such as the echelon grating spectrometer, and various interferometers and refractometers, and perhaps this is to be regretted, since the research chemist has sometimes to use such instruments and is often rather ignorant of the correct method of manipulation, and requires some handbook to guide him. However, the chapters on interferometers, diffraction, colours of thin and thick plates and polarised light will be most useful to the student of optics, who has hitherto had to search in many different volumes to find the many different instructive experiments the author has collected in these chapters. The chapters on vision, colour measurement, resolving power, the compound lens, and the microscope are thoroughly up to date, and contain a great deal of very useful information, useful both to the student and to the technician.

It remains to say that the printing, figures and general arrangement of the book are excellent.

A. C. G. E.

Principles of Physics.—By WILLIAM F. MAGIE, Ph.D. 570 pages. 281 illustrations. 9-in.×5½-in.

(G. Bell & Sons. Price 7/6 net.)

The author mentions in the preface that Physics is the one science of all others in which scientific reasoning is illustrated by the simplest and most varied examples. The peculiar advantages of the science as a means of intellectual training are not given sufficient attention, as physics is now commonly taught; and the author has endeavoured to present the subject in such a way as to direct attention particularly to the development of its various branches and thus to exemplify the processes of thought which are employed in the examination of a group of physical phenomena and the establishment of a physical law or theory. The book is consequently constructed upon the historical outline.

The result is an interesting survey of the science of physics, cramped in certain sections of the book a little too much, *e.g.*, electricity, but nevertheless a book useful both to the elementary student and especially to the man who requires a general outlook on Natural Philosophy without having to call to his aid his mathematical facilities, or to bother his memory with a host of details which must be included in any book on Physics which includes the numerous practical applications of the Principles of Physics. The author avoids complication by rigorously keeping only the main principles of the science, and by excluding many side issues, *e.g.*, dynamo-electric machinery, steam engines, and so on.

A. C. G. E.

An Experimental Course of Physical Chemistry.—Part I.: Statical Experiments.—By JAMES F. SPENCER, D.Sc., Ph.D. 228 pages. 65 illustrations. 7½-in.×4¾-in.

(G. Bell & Sons. Price 3/6.)

This work, says the author, has been written to provide the student of Physical Chemistry with a guide which shall enable him to carry out for himself the simple physiochemical operations. Dr. Spencer commences well with a chapter on errors and interpretation of results, and continues with a valuable chapter on the calibration of instruments, weights, measuring vessels, and thermometers, another on constant temperature baths, and on the manipulation of gases. These chapters are the most important part of the book, for knowledge of how to work accurately, and consequently of how to calibrate one's instruments, is all important to the physical chemist. When once apparatus is properly set up and its errors determined, accurate measurements are not difficult. Some account of the setting up of cathetometers, and reading microscopes and the calibration of fine capillary tubes might, with advantage, have been included.

The rest of the book deals with the determinations of various physical constants, and the descriptions are very clear and concise. Density, atomicity, molecular weights, solubility, viscosity, surface tension, polarimetry, spectroscopy, refractivity, and thermal measurements are dealt with in succession. A useful collection of tables is to be found at the end of this well got up and useful book. The student of physical chemistry will find most of what he wants in this small book and can always refer for greater detail to Ostwald and Luther's "Physiko-chemische Messungen"; the one is a laboratory working guide, the other a reference book. Another volume of dynamical experiments is to follow this volume shortly.

A. C. G. E.

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General Physics for Students.—By EDWIN EDSER. 632 pages. 285 illustrations. 7-in. × 4½-in.

(Macmillan & Co. Price 7/6.)

Mr. Edser's physical books, those on light and heat, are already very well known and much admired for their clearness and arrangement. The book on the Fundamental Properties of Matter now under review is part of the same series of books and is even of higher standard than the other two text books. It is a new book—that is to say, it contains material which was not to be found in any other book. Mr. Edser has collected together a great number of physical facts and principles into a small volume of six hundred pages, and arranged them so adroitly that there is neither cramping nor loss of clearness. A good book for the advanced student and research student on the properties of matter has long been required; the former working for examination had no time to consult the larger treatises, such as Chwolson's Treatise, and it was often not worth the research student's while to wade through a large mass of literature after a small matter. Mr. Edser's excellent book supplies the need. The chapters on the spinning top, on gravitation, on surface tension, and on the molecular structure of gases will be of great interest to all students of physics.

"The student who possesses a sound knowledge of the elements of algebra, geometry, and trigonometry will find his acquirements are sufficient to enable him to read the book without referring to mathematical treatises": this sentence is taken from the preface, and the author has been led thereby to work all proofs from first principles and to avoid the calculus as far as possible; this is a pity, perhaps, because the calculus simplifies many arguments, and most students of physics have at some time or other to get familiar with it; and it is somewhat irksome for the more advanced student to work through a proof from first principles each time. To some it is more pleasant to be led up to a subject from the mathematical standpoint and then to compare the experimental with the inductive results; others care to do the experiment, form a mechanical picture of what is happening and then to apply mathematics to get that picture into a more exact representation of what is occurring. Mr. Edser seems to prefer along with many other physicists, the former plan; the latter would appear the more natural to the elementary student. Only in a few places in this book does this tendency become apparent, and on the whole it is exceedingly clearly written and arranged.

The printing and diagrams are very good; there are very few misprints (on page 14 "melting" occurs instead of resulting).

The book is bound to please everyone in whose hands it finds itself, and is a valuable asset and help to those studying natural phenomena.

A. C. G. E.

Illumination: Its Distribution and Measurement.—By ALEXANDER P. TROTTER. 292 pages. 209 illustrations. 9-in. × 5¾-in.

(Macmillan & Co. Price 8/6.)

This book does not deal with the many illuminants of the present day, but rather with the methods by which they may be used to the best advantage, an equally important study. In order to be able to determine quantitatively the effect of an illuminant at any particular position it is necessary to be able to measure the intensity of the light at that place. Mr. Trotter has himself devised many useful forms of apparatus to attain this end and describes in addition all the other forms of apparatus in use. The book is a mine of information for the user of the Photometer. The author has worked up the history of this most important class of instrument and has presented a very complete account of its various forms. The three chapters on the distribution of illumination contain a great deal of useful original work which will be of great value to the engineer engaged in the proper lighting of buildings and streets.

The book is splendidly illustrated and is printed in very clear type; while it contains a valuable bibliography at the end. It will be indispensable to the user of photometers and to the illuminating engineer.

A. C. G. E.

NOTICES.

CHRISTMAS GIFTS.—In view of the approach of the Yule-tide gift season we would direct the attention of our readers to the fact that most scientific and optical instruments, including cameras, lend themselves admirably to the material expression of goodwill among relatives and friends, and that such, chosen with regard to the particular interests of the recipients, would be sure to find a warm welcome with them.

PHYSICAL TRAINING AT BIRMINGHAM.—We recently had the pleasure of seeing the work which is carried on at the Anstey Physical Training College, near Birmingham, and we hope soon to public an article dealing with the scientific side of Swedish Physical Exercises, by Miss Anstey, the Principal and Founder of the College. There is no quicker way to Birmingham than by the two-hour expresses of the London and North-Western Railway. No less than forty trains run daily between Euston and Broad Street and New Street—a most frequent service.

WELLCOME TROPICAL RESEARCH LABORATORIES.—Messrs. Baillière, Tindall and Cox, the well-known medical publishers, announce that they have been authorised by the Department of Education of Sudan Government, to publish immediately the Fourth Report of the Wellcome Tropical Research Laboratories, Khartoum. The Third Report was issued in 1908, since when a great amount of important research work has been accomplished, and the announcement that a further instalment is to be expected should arouse the keenest interest among students of Tropical Medicine.

The thorough examination of the conditions of tropical life, as they present themselves in men, animals, and plants, is the task to which this great institution is devoted, and the Fourth Report, which is in three volumes, contains facts, observations, and discoveries recently brought to light. It is the actual record, at first hand, of new contributions to the solution of problems of deep and world-wide importance.

The edition is, however, limited, and in order to ensure delivery of copies immediately upon publication, it is essential that orders should without delay be forwarded to the publishers.

TREASURE TROVE.—The Committee of the South Eastern Union of Scientific Societies on Means of the Preservation of Treasure Trove and other Relics, has issued a second edition of its pamphlet upon the law of Treasure Trove together with a sheet of illustrations showing in an attractive manner the sort of articles which may be found and ought to be preserved. Mr. H. Norman Gray, the honorary secretary, is sending copies to various county museums and other institutions for exhibition and reference, and although the Committee is inclined to the opinion that public museums should be the homes of all finds of interest, it is only concerned with the preservation of the finds, and therefore private collectors need have no fear from any action from this Committee. The printing and circulating of the literature entails a considerable amount of expense and the Committee invite contributions to aid it in its useful work.

SCIENTIFIC BOOKS.—We have received from Messrs. W. & G. Foyle their catalogue of technical and scientific books. The great feature of it is the way in which the various items are carefully listed under alphabetical headings. The index contains over two hundred different subjects, so that it is easy to find any one required without the trouble that usually has to be expended in looking through catalogues of books.

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